BRISTOL®
instruments/systems

instruction
manual

760
Series

Installation,

Operation

& Service

Bristol Division of Acco

40 BRISTOL STREET, WATERBURY, CT 06708 • (203) 756-4451
American Chain & Cable Company, Inc.
A Subsidiary of Babcock International Inc.

W18345-3B

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Replacement parts can be ordered from the Waterbury factory. Specify part numbers wherever possible. Be sure to include the instrument model and serial number with all parts orders.

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ELECTRICAL GROUNDING OF INSTRUMENT ENCLOSURES

Enclosures of electrical instruments must be grounded in accordance with the rules and regulations of Occupational Safety and Health Standard, Sect. 1910.314, dated May 29, 1971 (reference source: National Electrical Code, NFPA No. 70).

The grounding requirement is also applicable to mechanical instruments that include electrical devices.

NOTE

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the Bristol Division of ACCO, Waterbury, Connecticut 06708. As a measurement, control or protection device or system, customer should note that a failure of this instrument or system for whatever reason, may leave the monitored process unprotected. It is suggested that the customer review the need for further redundant or other alternate means of protection.

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W18340
8/78(D)

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Bristol Division of Acco

Index No. N20760

Issue 2/77 (A)

DYNAMASTER®

1 & 2 PEN STRIP-CHART RECORDER

SERIES 760

Serial _____ **Cust. Order** _____

Each booklet section of this manual is identified by an alphameric number appearing at the upper corner of each page. The filing sequence of booklets is listed below.

BOOKLET TITLE	NUMBER
Strip Chart Recorder - Installation, Operation & Service	P12600-A
Series "S" Amplifier - Theory & Service	P12578
Parts List - Recorder	P12605
Parts List - Amplifier	P12578-1 P12514
SUPPLEMENTAL DRAWINGS	850200-22-9 850325-41-2 850336-03-1

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BRISTOL®
instruments/systems

instructions

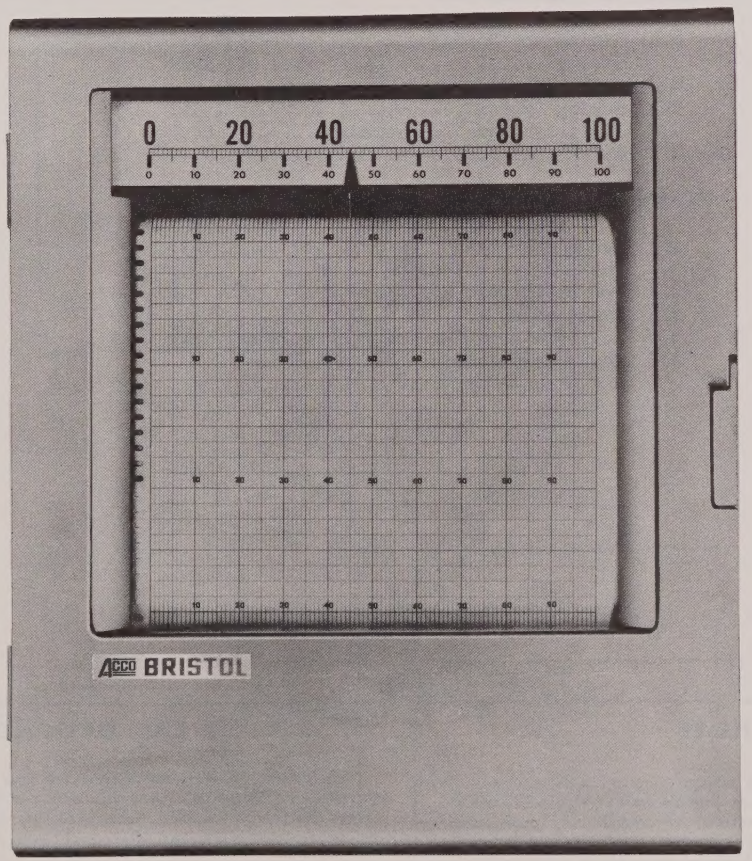
10/79 (D) P12600-A

(includes parts list)

DYNAMASTER®

STRIP CHART RECORDERS

SERIES 760



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Introduction

1.1 DESCRIPTION

Series 71A-760 Dynamaster one or two pen strip chart recorders are designed to record one or two measured variables on a 7-inch strip chart. The recorders function on the null-balance principle employing a servo amplifier to operate the balancing motor and drive the pen and indicating mechanism. The null balance bridge network may utilize either potentiometers or d-c bridge networks to perform the derivation of an error voltage required to drive the balancing motor.

1.2 THEORY OF OPERATION

The variable voltage being measured is applied to a filter to remove undesireable outside electrical interference that would cause offset or instability. Once filtered, the signal is fed to a resistance bridge circuit that includes a servo driven slidewire in one of its branches. Also connected to the bridge network is a d-c voltage derived from a zener reference supply. The bridge is balanced when the input potential at the junction of resistors D and E (reference figure 1) equals the potential on the slidewire contact arm.

When a change of input signal occurs, the input voltage no longer equals the slidewire reference voltage and the bridge becomes unbalanced. A differential voltage between the input and the slidewire reference voltage is developed at the input of the amplifier. The error voltage is applied through a d-c chopper and transformer circuit that interrupts it at power line frequency rate. The error voltage, therefore, is converted to an a-c signal and amplified to a level sufficient to drive the servo motor.

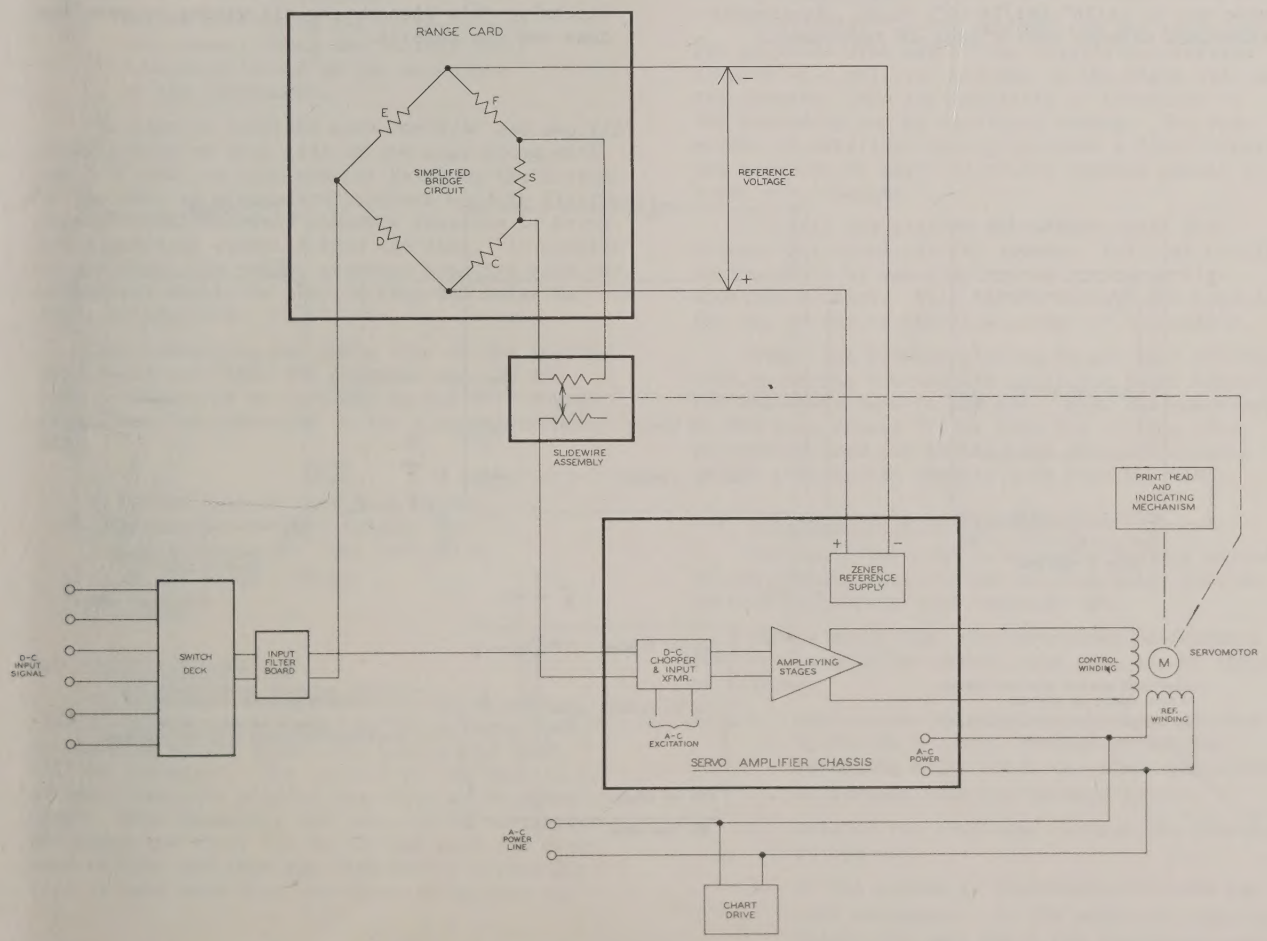

Figure 1. Basic Recorder Block Diagram

The servo motor has two windings: one winding is excited by the amplifier and the other by the a-c power line voltage. The latter winding functions as a reference for the error voltage. The servo motor will rotate in a clockwise or counterclockwise direction dependent upon the polarity of the error signal from the amplifier. As the motor rotates it simultaneously positions the slidewire contact arm and the pen along with the indicating mechanism. When the potential derived from the position of the slidewire equals the reference voltage on the opposite side of the bridge the motor ceases movement and the bridge is then in balance.

Installation

2.1 SITING AND MOUNTING

The Series 71A-760 recorder is designed for flush mounting only. The recorder should be located as remotely as possible from the effects of dust, dirt, vibration, corrosive fumes and extremes of temperature. The site should also be convenient for service and general utilities.

The case is mounted by four (4) toggle bolts. The panel cutout should be 10 7/16" (+1/16 -0") wide and 12 11/16" (+1/16 -0") high. Horizontal clearance between centerlines of instruments should be no less than 13". Vertical clearance between center lines of instruments should be no less than 15 1/4".

To mount the instrument, the chassis must be withdrawn from the case. To remove the chassis from the case perform the following: first open and remove door by lifting upwards. Next, disconnect terminal straps from back of case (it is not necessary to disconnect cables from terminal blocks). This disconnects all wiring between the case and the chassis.

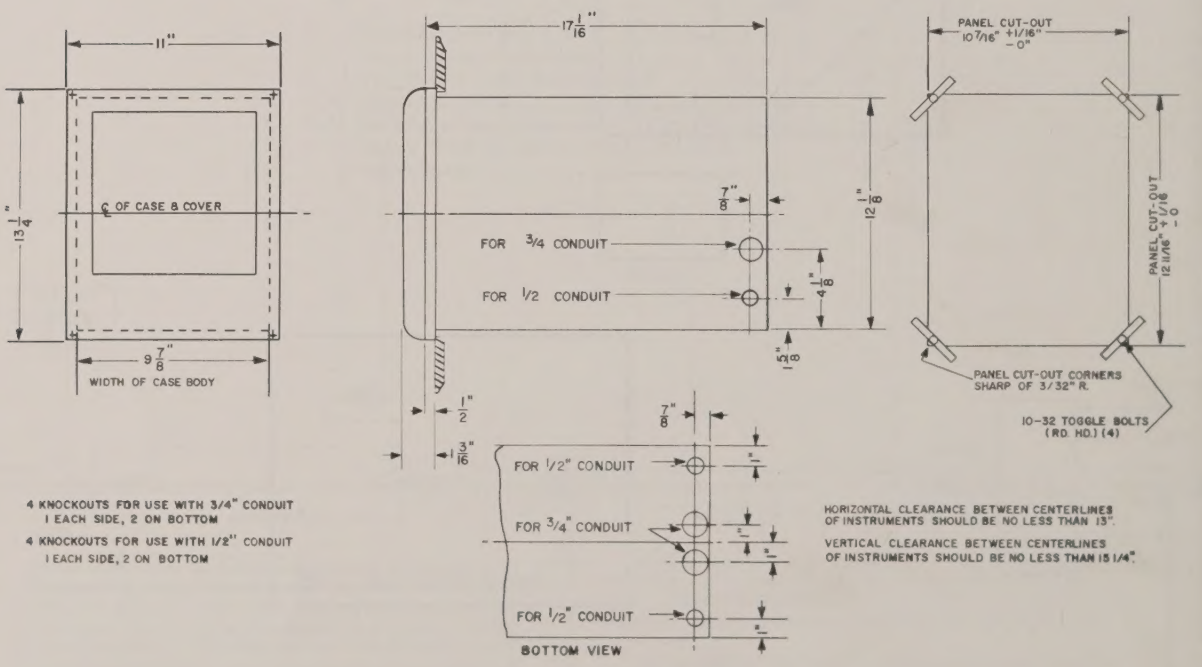

Figure 2. Mounting Dimension Drawing

Using the levers located on the lower right and left front sides, pull chassis out of case as far as the first stop in the guide channels. The levers must first be lifted upward to release the chassis from the case. Using both hands (one on either side of chassis), depress detent clips and slide chassis out of case.

Emplace the case and secure by inserting four (4) bolts in the four (4) corner holes of the case and secure the toggles on each of the bolts. Insert case in panel cutout and tighten bolts until case is held rigidly to the panel. Replace chassis and refasten terminal straps to original position on the rear of the case.

NOTE

Be sure to replace terminal straps with the coil cord clamp at the top of the case.

2.2 WIRING

CAUTION

Before connecting any wires to the instrument, check the voltage and frequency listed on the nameplate of the instrument.

The case is provided with one 3/4" and one 1/2" conduit hole on each side of the case along with two 3/4" and two 1/2" conduit holes on the bottom of the case to accomodate standard conduit fittings. Conduit should be used whenever possible to bring all electrical circuits into the case. If conduit is not used, the rubber grommets supplied with the instrument should be used to keep the holes as tight as possible.

When connecting the power line to the instrument, make sure that the grounded side of the line is connected to terminal marked L2. A good ground must be connected to the terminal marked GND.

NOTE

Do not install measuring circuit wiring in the same conduit with power line wires that contain up to 120 volts @ 60 Hz.

2.3 CHART INSTALLATION

Install the two spindle hubs which are included with the accessories in the packing case, in the ends of the chart roll before the chart roll is installed. The purpose of the hubs is to prevent excessive play as the chart is being unwound. When inserting the hubs, it is advisable to insert the first hub in the end with the chart perforations and then tap this end on a flat surface to make sure that the chart is squared up.

Open door of recorder and pull chassis out about six (6) inches. Push down on the two levers above the lock release levers and the chart drive assembly will drop forward. Place feed roll in trough with pressure plate on top of chart roll. Unroll portion of chart and attach end of chart to cardboard core with tape. Place spindle hub with bearing pin in left hand end of chart core and the spindle with the hex socket in the right hand end of the chart core. Unroll sufficient chart to permit passing rewind roll under and around in back of chart drive assembly. Insert right hand end of chart rewind spindle in hex shaft of rewind drive and press inward (from left to right) to permit bearing pin in left hand spindle to slip into the slot in plate and hole of spring plate. Swing chart assembly back to its original position. Chart may be made taut by pulling upward on rear portion of spring. Be sure to properly locate the slots in the chart over the drive pins at left end of drive roll.

2.4 INKING SYSTEM

The Series 71A-760 one and two pen recorders are provided with one or two plastic ink bottles located on a pull-out bracket on the right side of the chassis. The ink bottle(s) is connected to the recording pen by capillary tubing. The prescence of capillary tubing provides a light tracking pressure so that the pen(s) respond easily to input step changes.

To fill the plastic ink bottle, pull the chassis out about six (6) inches. Pull ink bottle horizontally by means of the wire ring on its mounting bracket. Fill bottle through the hole in the top as far as the line marked on the bottle.

Start ink flow by placing finger over filling hole in bottle and squeeze until ink flows through the capillary tube to the pen. When the ink reaches the pen, remove finger from the filling hole. Be sure to push ink bottle back into the chassis before pushing the chassis back into the case.

2.5 AMPLIFIER GAIN ADJUSTMENT

The amplifier gain is normally factory adjusted for optimum response and will normally need no further adjustment upon installation.

In the event that the instrument performance does not seem to be correct, the gain may be checked follows:

1. Apply power and allow instrument to warm up for 30 seconds. Manually turn the balancing motor shaft to offset pen several percent from the balance point.
2. Release the shaft and observe the behaviour of the pen.
3. If the system is over-sensitive, the pen will overshoot. In the event of overshoot, reduce the gain until the overshoot condition is eliminated.

4. If the systems response is sluggish, increase the gain (clockwise rotation) until the system overshoots and then reduce the gain until the overshoot is just eliminated.

2.6 MECHANICAL STOP ADJUSTMENT

All Series 71A-760 recorders are provided with a mechanical stop set so that the pen is mechanically stopped at a point .025" below the calibrated zero. All charts are printed with a dash line .025" below the calibrated zero; the calibrated zero being the low end calibration line on the chart.

To check the mechanical stop; set the instrument power switch to OFF. Rotate the balancing motor shaft in a direction to drive the pen downscale as far as it will go. If pen is not on the dash line, loosen the two screws and shift the stop bracket as required. Tighten screws after adjustment.

Service

3.1 TROUBLESHOOTING

Should the recorder fail in any way, it is first necessary to determine which part is faulty. The following procedure is suggested in order that repairs may be accomplished with a minimum of lost time.

1. Power Supply Check. Using an a-c voltmeter check for line voltage across instrument power terminals L1 and L2 on back of case, chassis and front frame of chassis.

2. Amplifier-Motor Check. Remove amplifier input connector and apply a d-c voltage (approximately 10 mv) from a test set to the amplifier input. The pen should drive to one end of the scale. Reverse the test set polarity and the pen should drive to the other end of the scale. If the instrument does not drive, the fault is in the amplifier or motor.

3. Amplifier Check. Remove the amplifier input connector and apply a d-c voltage (approximately 10 mv) from a test set to the amplifier input. Measure the a-c drive voltage across the red and blue motor leads at the chassis terminal block. The voltage should be about 15 volts a-c.

If the voltage is not present, replace the amplifier. The amplifier may be removed by loosening the two holding screws, sliding the amplifier until the larger slotted holes are in line with the screws and then removing the amplifier.

4. Balancing Motor Check. With the power switch set to OFF, disconnect the motor leads from the chassis terminal block. Measure the d-c resistance of the control winding (red and blue) and reference winding (black and white). The control winding should be approximately 10 ohms and the reference winding should be approximately 670 ohms. If any open or short is indicated, replace the motor.

If the d-c resistance is normal, connect the white and blue leads to terminal L2, the black lead to terminal L1. Add a 2 to 10 mfd paper or non-polarized electrolytic capacitor from L1 to the red lead. Do not connect the red lead directly to L1 as the control winding is rated for only 15 volts. Set the instrument power to ON. The motor should drive the pen to one end of the scale. If there is no drive, replace the motor.

5. Recording System Check. The recording system is mechanical. It includes the chart drive and its gear train, chart feed roll, pen drive cord and associated pulleys, etc.

Check the recording system for mechanical troubles, such as loose or binding gears, pulleys, etc. Move the pen up and down scale manually by turning the balancing motor shaft (with power off). It should move freely from one end of the scale to the other.

Feed the chart manually by turning the feedroll knob counterclockwise. The tension of the feedroll clutch should be felt, but the chart should feed straight and smooth without tearing or distorting the holes. The pen should make a clean, legible record.

6. Troubleshooting Tips. In general, the following symptoms of troubles described below are caused by definite faults.

SYMPTOM	POSSIBLE FAULTS
Pen remains stationary regardless of changes in the value of the measured variable.	1. Power Failure 2. Defective Line Fuses 3. Defective Amplifier 4. Open Circuit in Measuring Element 5. Defective Balancing Motor
Pen records incorrect values.	1. Defective Measuring Element 2. Incorrect Gain Adjustment.

Pen Fails to record properly.	1. Kinks in Capillary Tubing 2. Pen Nib Not at right angles to Chart. 3. Failure of Ink Flow.

Check entire length of capillary feed tube for kinks. If a kink is found, disconnect capillary from pen and straighten tubing.

The pen nib must be set at right angles to the chart in order to assure proper inking. If it is not, check to see if the pen has been bent in any way. If so, be careful when straightening it so as not to cause a kink.

If it is found that the pen nib does not rest on the chart, a small adjustment of the setscrew located on the right side of the pen holder, is needed. When the pen is lifted from the chart and released, it should fall of its own weight until it rests on the chart.

If the above steps have been completed and it is found that the pen still does not record, this means that there is a stoppage and the capillary system needs cleaning.

To clean the capillary system, proceed as follows:

1. Pens. Lift pen away from chart and clean out pen nib by inserting pen cleaning wire (supplied with instrument).
2. Capillary Tubing.

NOTE

Before starting the cleaning process it is recommended that a piece of absorbent paper be placed under the pen to absorb any excess fluid that might be present at the pens during the cleaning process.

Fill an empty plastic ink bottle with warm water and substitute this for the standard ink bottle. Place index finger over filler hole and squeeze bottle to force water through capillary and pen. Repeat this action to assure proper cleaning.

After cleaning the capillary, be sure to clear the capillary of water by squeezing the plastic bottle while the filler hole is open, then closing the filler hole and releasing the pressure on the bottle. This will remove any residue in the capillary back into the bottle.

SYMPTOM	POSSIBLE FAULTS
Chart does not feed properly.	1. Chart is not lined up properly. 2. Feed-roll clutch is slipping.
Chart speed is incorrect.	1. Wrong change gears. 2. Defective Drive Motor. 3. Incorrect power supply frequency

3.2 CHART SPEED SELECTION

All instruments contain a double gear identified as gear B & C to control chart drive speed. To change speed, move the motor pinion gear A in or out on the motor shaft and mesh it with either gear B or C as required.

Prior to changing chart speeds, check the chart drive motor nameplate to determine its speed in RPM or RPH.

Next, locate the column in the following table for the motor installed. Read down the column to find the desired chart speed then read across the table to determine the change gears required to obtain the desired speed. If the chart speed required is not listed in the column under the motor installed, check the column for the other two motors.

To change from one chart speed to another may require either a change in the position of gear A, another gear A, a change in motors or a combination of these changes. Note that gear B is always a 48 tooth gear and gear C is always a 24 tooth gear. Gear B & C are combined to form a double gear and are a permanent part of the idler gear assembly.

When changing gear A, first loosen screw and move idler gear B & C out of the way. Install new gear A on drive shaft in a position to mesh properly with either gear B or C as called for in the table for the speed required. Move idler gear assembly until gear B or C meshes properly with gear A and secure by tightening screw.

CHART DRIVE MOTORS						CHANGE GEARS			
2 RPM 120V 60 Hz 310497-00-0	2 RPM 120V 50 Hz 311730-00-0	8 RPM 120V 60 Hz 310393-00-0	8 RPM 120V 50 Hz 311731-00-7	8 RPH 120V 60 Hz 310394-00-7	8 RPH 120V 50 Hz 311732-00-3	GEAR POSITION	TEETH	PITCH	PART NUMBER
CHART SPEED INCHES/MIN.				CHART SPEED INCHES/HR.					
3/16	3/16	3/4	3/4	3/4	3/4	A B*	12 48	64 64	310402-00-0 310342-00-7
1/4	1/4	1	1	1	1	A B*	16 48	64 64	310399-00-9 310342-00-7
3/8	3/8	1 1/2	1 1/2	1 1/2	1 1/2	A C*	12 24	64 64	310402-00-0 310342-00-7
1/2	1/2	2	2	2	2	A C*	16 24	64 64	310399-00-9 310342-00-7
3/4	3/4	3	3	3	3	A B*	48 48	64 64	310398-00-2 310342-00-7
1	1	4	4	4	4	A B*	64 48	64 64	310395-00-3 310342-00-7
1 1/2	1 1/2			6	6	A C*	48 24	64 64	310398-00-2 310342-00-7
2	2			8	8	A C*	64 24	64 64	310395-00-3 310342-00-7

*Gears B & C are combined to form a double gear

Table 1. Single-Speed Chart Drive Gears and Motors.

3.3 PEN DRIVE CORD REPLACEMENT

The pen cord drive cord may be replaced by loosening the drive cord clamp on the drive cord sheave, loosen the drive cord clamp on the pen assembly and remove the old cord. Turn the drive cord sheave so that the clamp is at the top. Loop end of cord completely over pin on sheave. Lay cord over sheave (front groove) and around the right hand rear pulley, then around the right hand front pulley, across the front of the instrument around the left hand front pulley, around the left hand rear pulley and around the sheave (rear groove) and hold in position with fingers. Attach cord spring to end of cord and hook free end of spring into hole in sheave.

Adjust the drive cord for tension by rotating the sheave to take up any slack. Shift the rear pulleys, as required, to align cord in sheave grooves. Rotate sheave again and move spring into an adjacent hole in sheave, if necessary, to attain proper tension on cord. Tighten cord clamp.

Clamp pen assembly to cord after ensuring that the pen is correctly zeroed by turning the main drive gear by hand until it hits the low stop.

Center the pen exactly on the lowest division of the chart (usually zero) and clamp the drive cord securely.

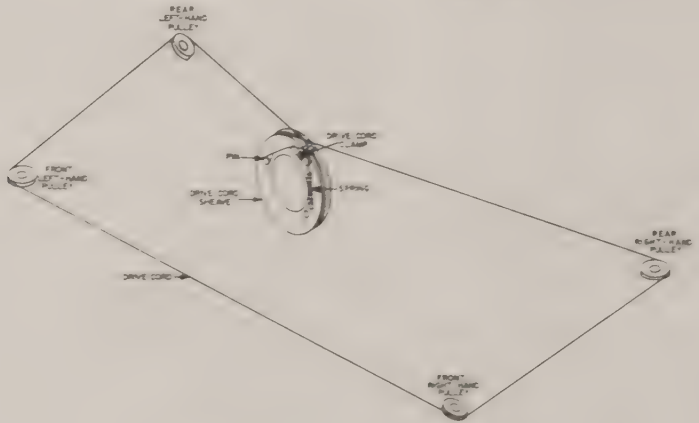

Figure 3. Pen Drive Cord Assembly

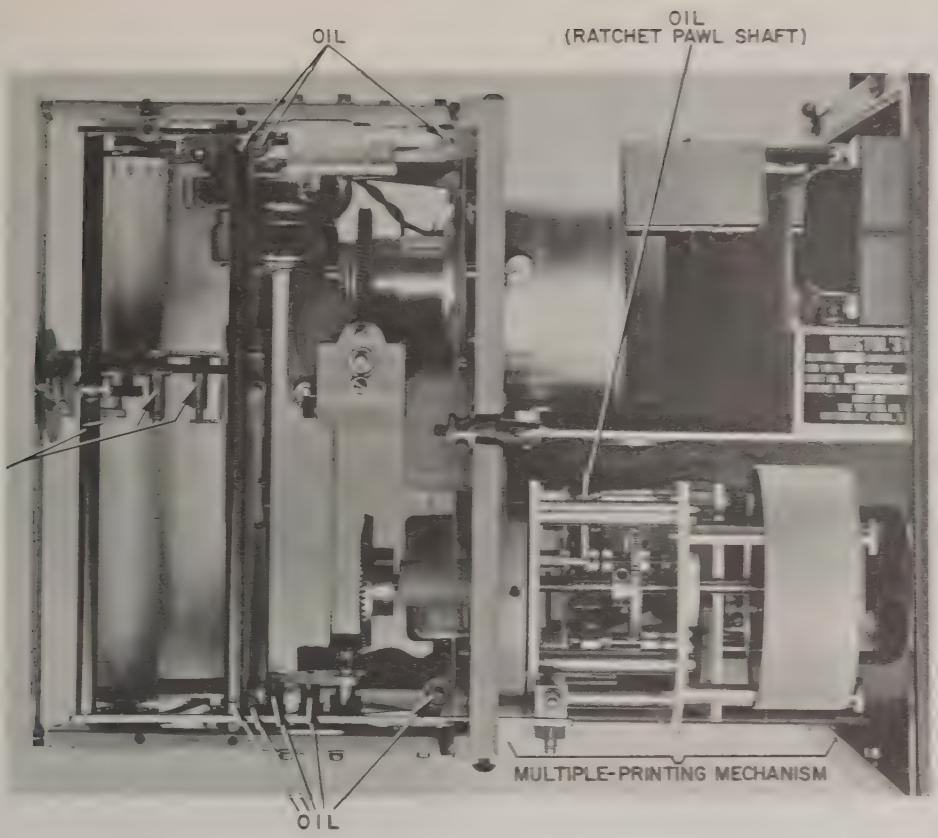

Figure 4. Lubrication Points on Multiple Point Recorders

3.4 LUBRICATION

A drop of Gulf electric motor oil is required annually on each of the four (4) ball bearing pulleys of the drive cord assembly.

1. Multiple Point Recorders Only. Place a drop of oil on the ratchet pawl shaft and on the locations that mechanical wear will occur.

There are three oil holes in the print wheel assembly. The print wheel and ink pad must be removed to gain access to two of these oil holes.

Holtzer-Cabot gear case motors, used on the multiple-switching mechanism should be oiled every three (3) months with three (3) cc's of Houghton Gearlub 890 (Bristol Part No. 291982-00-0 for 2-ounce can).

No other points should be oiled in the recorder. All other bearings are either dry (and should be kept clean) or are permanently sealed and require no lubrication during their normal lifetime.

The selector switch contacts are normally self cleaning. If it should become necessary to clean these contacts, they should be cleaned with a cloth and a solvent such as Bristol cleaning fluid (Part No. 305700-00-6). After cleaning, the contacts should be lubricated with a very thin film of Cramolin. It is not necessary to remove the brush arm when cleaning the contacts. The brush arms may be rotated counterclockwise without damaging the unit or getting the print wheel out of step. If the brush arm is ever removed, note carefully the contacts on which the brush arm rests so that it may be returned to the same position. In addition to locating the brush arm correctly, the brush arm assembly should be pressed firmly against the hub of the switch contact plate before tightening its setscrew. This guarantees the correct pressure on the contacts. The switch contact plate hub has a locating pin that fits into a hole in the brush arm assembly. In this way, it the brush arm is taken off, the arm can be easily and correctly returned to its synchronized position. Always push brush arm tightly against hub of contact plate before retightening its setscrew.

3.5 MULTIPLE POINT RECORDER PRINT WHEEL CARE

When the printed record becomes too light for easy reading, the ink pads should be changed. The single color ink pad may be replaced by removing the thumb nut and sliding off the old pad. The multi-colored pads should be replaced one at a time so that the color sequence will not get mixed up. When replacing the pad holder in the multi-color unit, be sure to line up the holder with the hole in the gear and the hole in the indicating disk.

3.6 CHART-ROLL PRESSURE PLATE TENSION ADJUSTMENT

The pressure plate used to hold the chart feed roll in position is provided with two springs to provide the necessary pressure. If the pressure plate exerts too much pressure on the chart feed roll, the left end of the right hand spring may be dropped through a slot in the plate to reduce the tension.

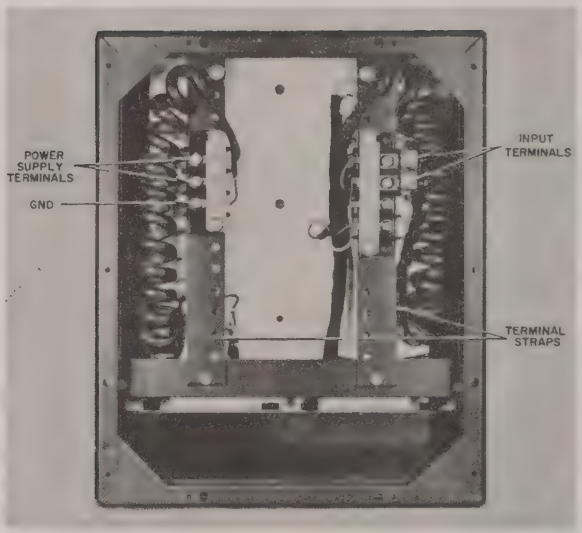

Figure 5. Rear View of Case With Back Cover Removed.

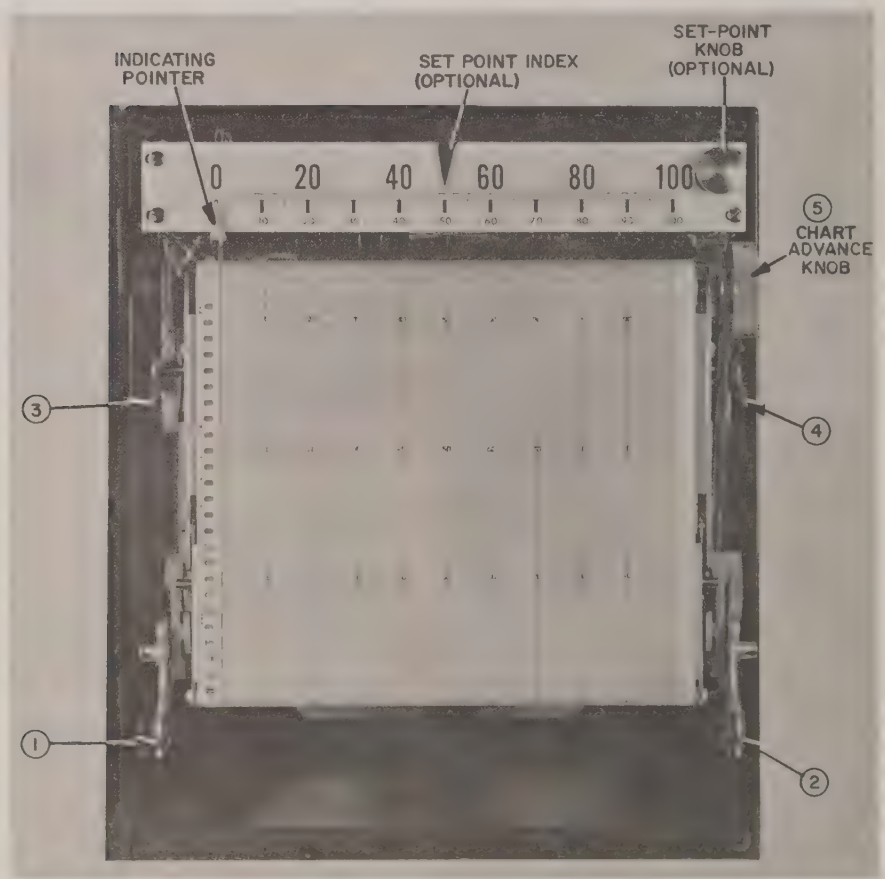

Figure 6. Front View With Door Open.

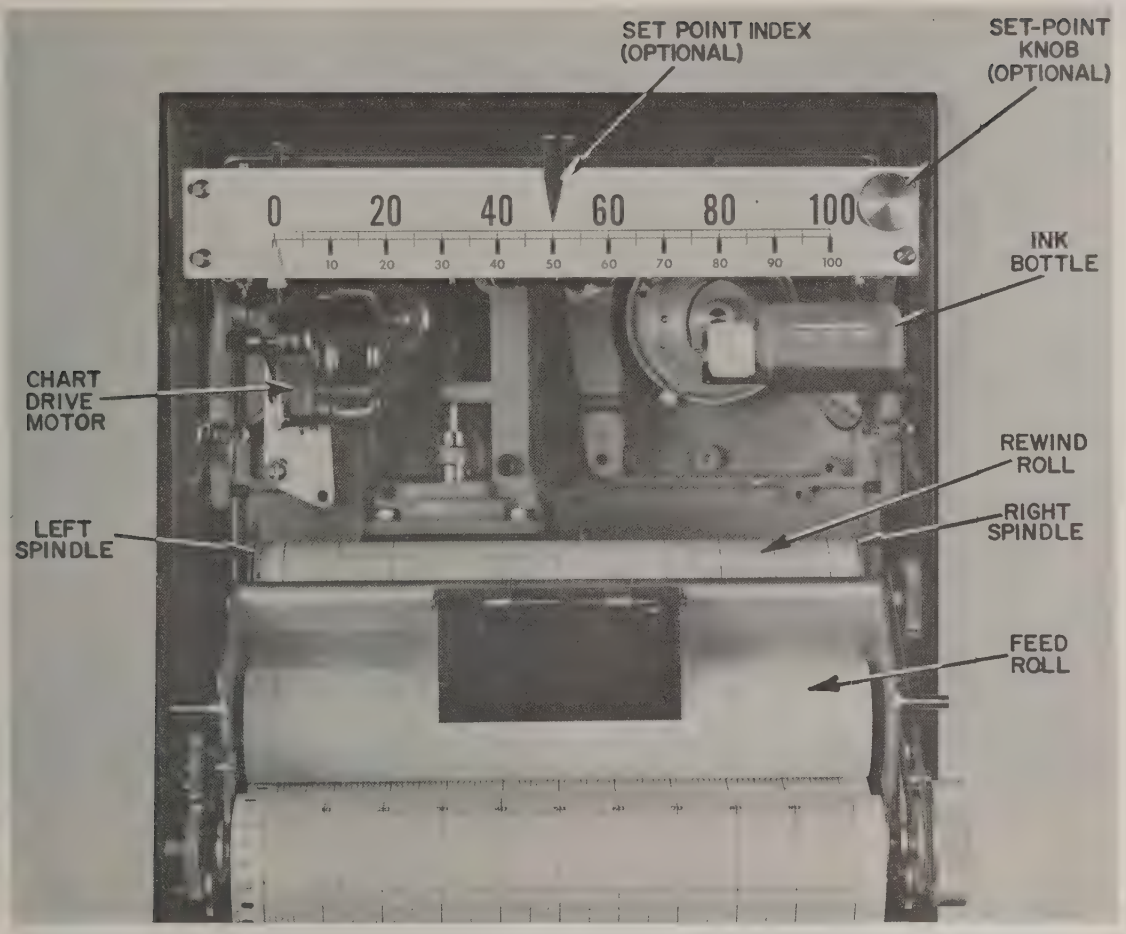

Figure 7. Front View of Chassis With Chart Drive Dropped Down.

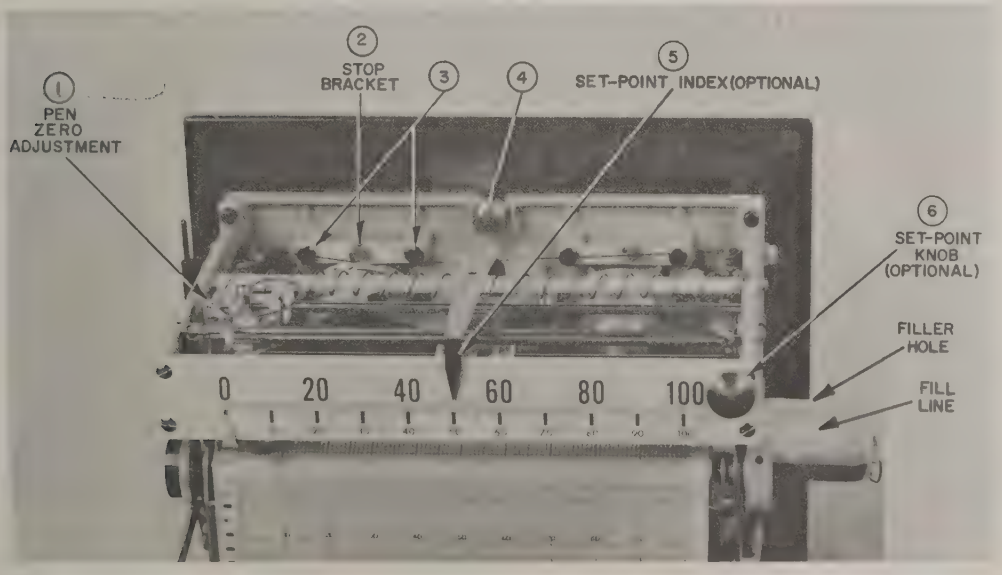

Figure 8. Front View Showing Ink Bottle Pulled Out.

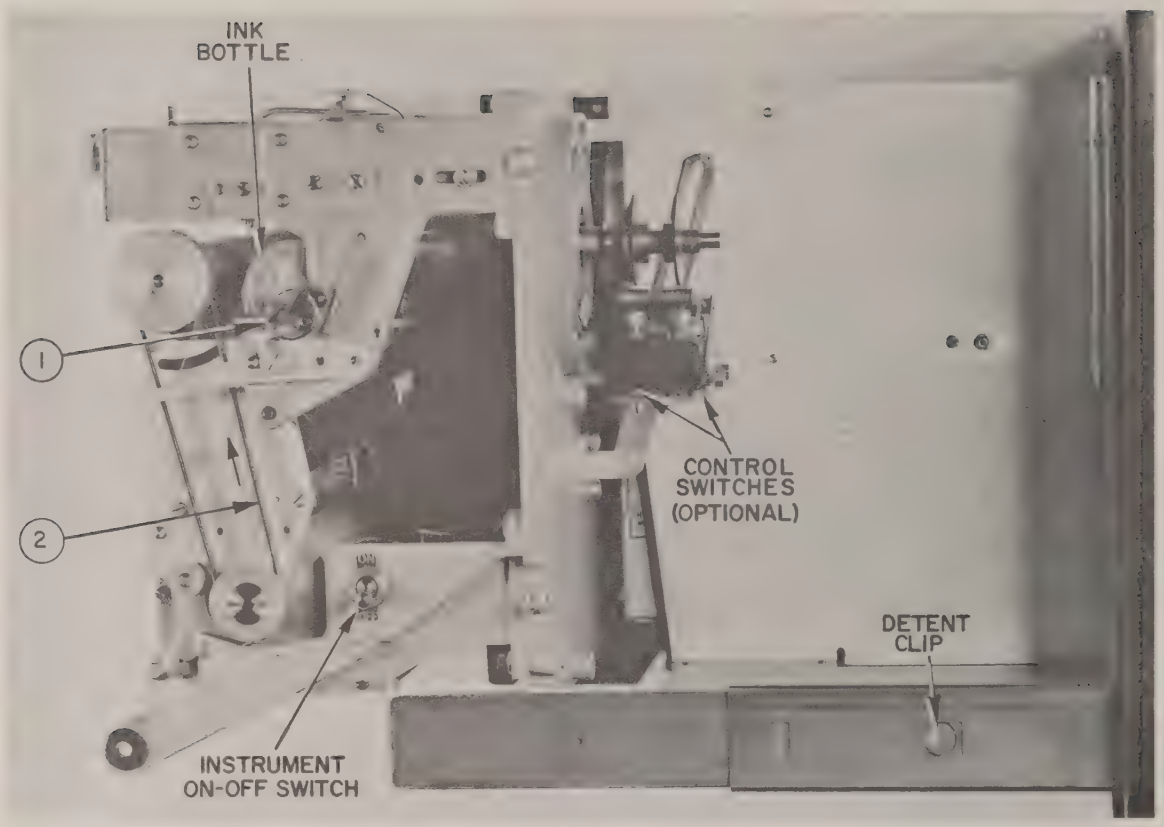

Figure 9. Right Side Of Chassis.

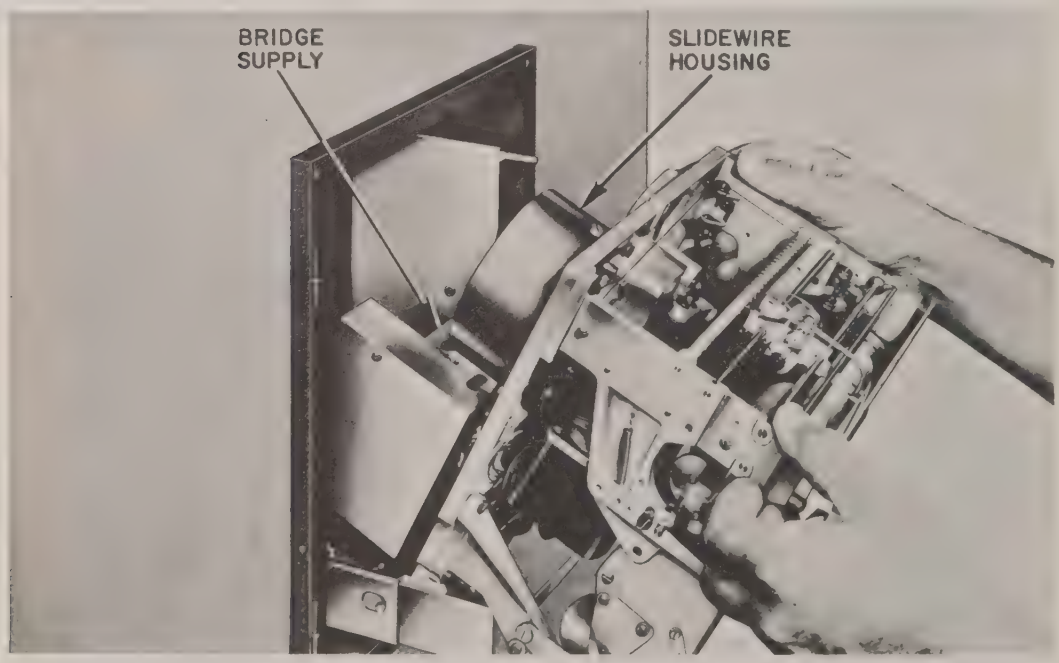

Figure 10. View Showing Hinged Frame Swung Down.

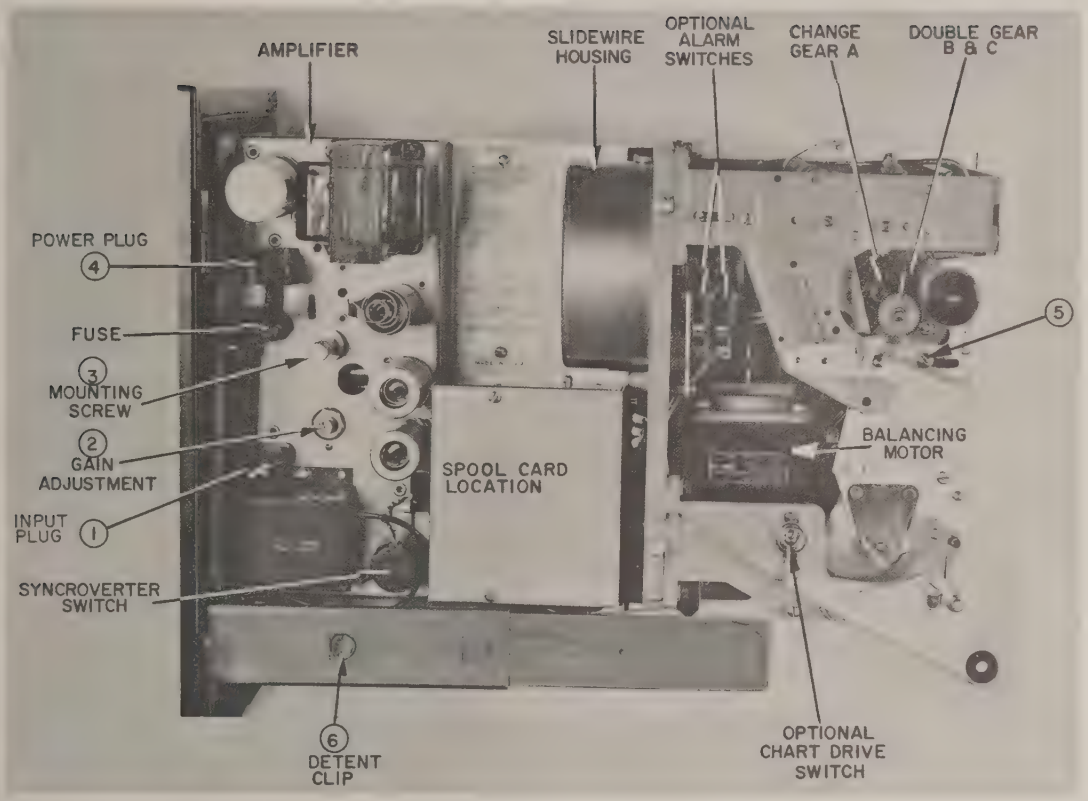

Figure 11. Left Side Of Chassis

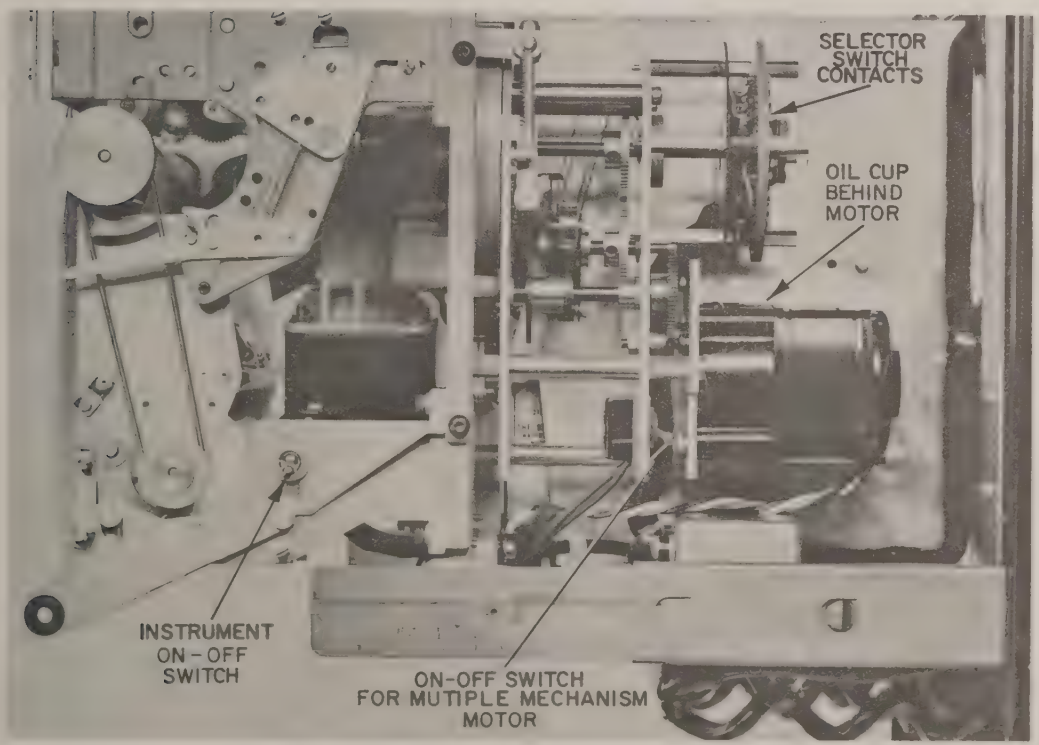

Figure 12. Right Side Of Multiple-Point Chassis

DYNAMASTER®

Strip-Chart Recorders
Series 760

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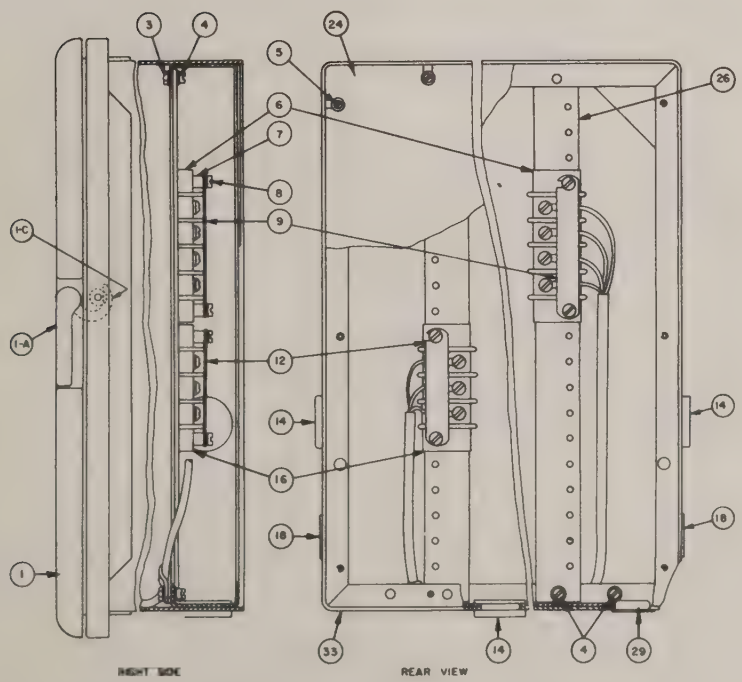

FIGURE 1 SIDE AND REAR VIEWS OF CASE

BREAKDOWN OF SERIES 760 CASE
(Refer to figure 1)

ITEM	PART NUMBER	DESCRIPTION
1	———	Door Assembly (order by instrument model & serial number). The complete door includes all parts listed under item 1:
1-A	———	Handle (order by instrument model & serial number)
1-B	310307-00-7	Spring (not shown)
1-C	310308-00-3	Hook
1-D	310309-00-0	#6-40 Special setscrew (not shown)
1-E	302868-00-3	Gasket—45" (not shown)
1-F	310310-00-8	Gasket—Black spring cork (not shown)
1-G	310311-00-4	Window Glass (not shown)
1-H	310313-00-7	Clip (not shown)
1-J	282656-00-6	#6-32 x 3/16" Self-tapping screw (not shown)
1-K	310314-00-3	Right-hand chart shield (not shown)
1-L	310315-00-0	Left-hand chart shield (not shown)
1-M	277982-00-6	#6-32 x 3/16" Fillister-head screw (not shown)
1-N	310370-00-0	Bottom shield (not shown)
3	262618-00-1	#10-32 Nut
	235638-00-5	Shakeproof washer
4	266539-00-9	#10-32 x 3/8" Fillister-head screw
	210075-00-7	Washer
5	275373-00-2	#6-40 x 1/4" Washer-head screw
6	287236-00-5	Terminal Block 4-point (1-Pen & Mult. Print Models only)
	276643-00-3	Terminal Block 8-point (2-Pen Models only)
7	272166-00-6	Spacer
8	287936-00-7	#10-32 x 1" Self-tapping screw
	210075-00-7	Washer
9	310886-00-7	Marking Strip (1-Pen & Mult. Print Models only)
	310898-00-5	Marking Strip (2-Pen Models only)
12	310887-00-3	Marking Strip
14	272691-00-3	Rubber plug
16	287235-00-9	Terminal block (3-point)
18	307276-00-7	Plastic plug
24	332634-00-3	Rear cover plate
26	332688-00-3	Mounting strap
29	291250-00-9	Metal plug
33	———	Case Body Assembly (order by instrument model & serial number). The complete case includes all parts listed under item 33.
33-A	310303-00-1	Roller (not shown)
33-B	310304-00-8	#6-40 Shoulder screw for roller (not shown)
33-C	213775-00-0	#6-40 Nut for roller (not shown)
33-D	243040-00-8	Lockwasher for roller (not shown)
33-E	333515-00-5	Intermediate Channel & Center Track (not shown)
33-F	314444-00-9	Stop (not shown)

BE SURE TO STATE MODEL AND SERIAL NUMBER OF INSTRUMENT WHEN ORDERING PARTS

When ordering replacement parts, be sure to specify part description, part number, model number and serial number.

W18341-2E

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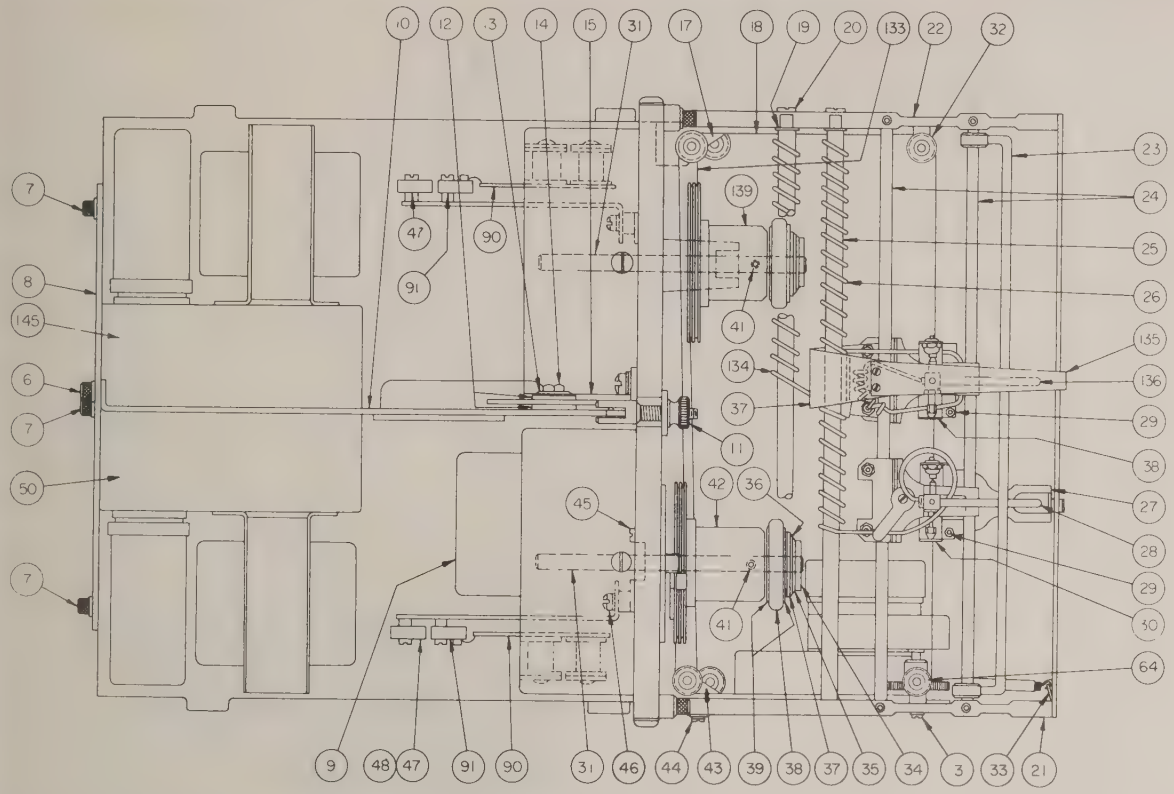

FIGURE 2 TOP VIEW OF CHASSIS

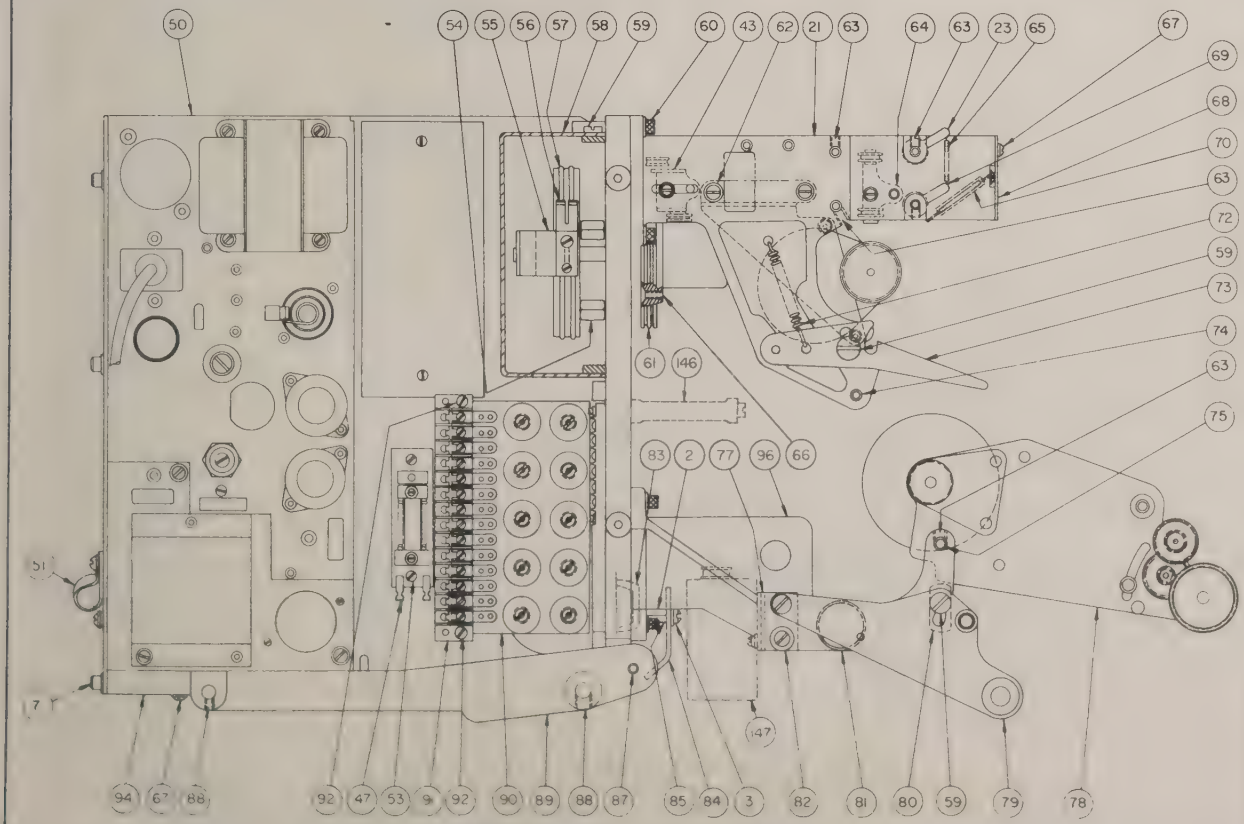

FIGURE 3 LEFT SIDE OF CHASSIS

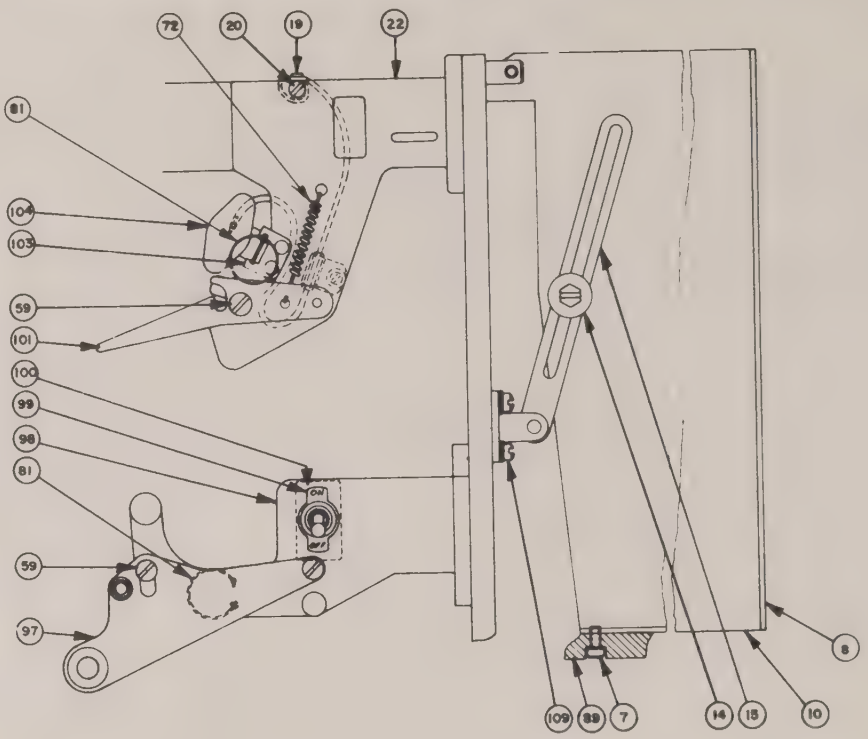

FIGURE 4 RIGHT SIDE OF CHASSIS (CHART DRIVE REMOVED)

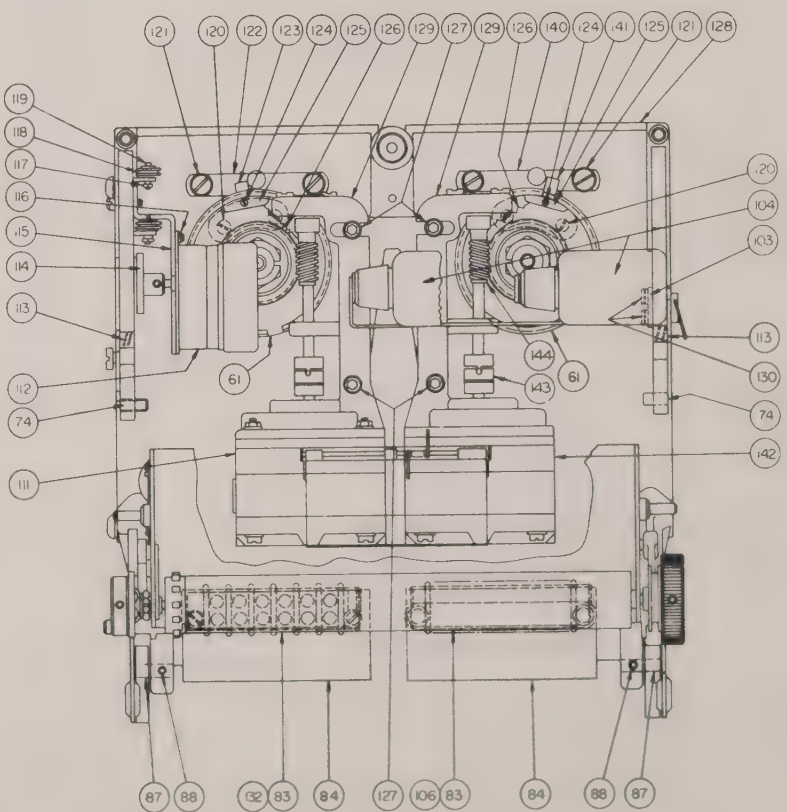

FIGURE 5 FRONT VIEW OF CHASSIS (CHART DRIVE FOLDED DOWN)

This breakdown covers both 1-pen and 2-pen Recorders.

(Refer to Figures 2,3,4 & 5)

ITEM	PART NUMBER	DESCRIPTION
2	301998-00-0	Post
3	239770-00-5	#6-40 x 1/4" Fillister-head screw
	221252-00-2	Washer
6	310889-00-6	#8-32 x 1/4" Hex socket head screw
7	310455-00-6	#8-32 x 5/16" Hex socket-head screw
	228543-00-2	Lockwasher
8	310461-00-6	Gusset (rear)
9	333547-00-4	Reference voltage source (order with mounting feet 312239-00-9,2 reg.)
10	332657-00-0	Partition complete with thumbnut assembly
11	216253-00-4	Thumbnut
	310453-00-3	Washer
	310499-00-3	Spring
12	310453-00-3	Washer
13	261812-00-9	Spring Washer
14	287392-00-7	Screw (door stop)
15	310454-00-0	Door stop complete
17	310431-00-0	Rear pulley bracket (right carriage)
18	310486-00-9	Cord complete for #1 pen drive
19	310860-00-8	Tab (tube)
20	269109-00-5	#6-40 x 1/2" Special-head screw
21	332683-00-1	Left hand pen carriage bracket Includes lever arm (73), spring (72), fwd. pulley bracket (64), & rear pulley bracket (43).
22	332682-00-5	Right hand pen carriage Bracket Includes lever arm (101), spring (72), fwd. pulley bracket (32) & rear pulley bracket (17).
23	310451-00-0	Pen lifter (upper)
24	310404-00-2	Guide rod
25	310862-00-0	Guide rod (ink supply)
26	310488-00-1	Ink supply tube
27	332652-00-9	Indicator #1 position
28	313244-00-6	Pen #1
29	237603-00-4	#2-64 x 3/16" Fillister-head screw
	268791-00-7	Lockwasher
	219890-00-5	#2 Hex nut
30	310434-00-9	Pen guide assembly for #1 pen
31	310385-00-8	Shaft complete
32	310431-00-0	Fwd. pulley bracket (right carriage)
33	264536-00-2	Lug
34	303874-00-7	1/2-27 Nut with slot
35	279235-00-3	Washer
36	315414-00-6	Washer
37	275854-00-0	Washer
38	304566-00-4	Potentiometer worm wheel for 1-sec. pen speeds
	310882-00-1	Potentiometer worm wheel for 5-sec. pen speeds
39	312705-00-0	Clutch washer
41	304414-00-0	#8-32 x 3/16" Flat-point setscrew
42	310387-00-0	Clutch hub for #1 pen
43	310430-00-3	Rear pulley bracket (left carriage)
44	258073-00-4	#6-40 x 7/16" Fillister-head screw
	243040-00-8	Shakeproof washer
	221252-00-2	Washer
45	302734-00-7	#6-40 x 1/4" Special-head screw
46	240067-00-2	#8-32 x 3/8" Fillister-head screw
	235638-00-5	Shakeproof washer
47	———	Trimmer potentiometer (order by instrument model & serial number, or from list below).
	331505-00-2	2-ohm Trimmer Pot
	295412-00-3	8-ohm Trimmer Pot
	295413-00-0	16-ohm " "
	296140-00-7	24-ohm " "
	296168-00-9	40-ohm " "
48	310373-00-0	Mounting bracket for trimmer potentiometer
	———	Amplifier for #1 pen mechanism (order by model & serial number) NOTE 1.
51	295382-00-7	Cable clamp
	275373-00-2	#6-40 x 1/4" washer head screw

ITEM	PART NUMBER	DESCRIPTION
53	218339-00-3	#6-40 x 3/16" Fillister head screw
54	310846-00-5	Slidewire mounting post
	309835-00-3	#6-40 mounting screw (located inside slidewire assembly)
55	371017-00-3	Contact arm only
56	331464-00-4	Contact arm (order by instrument model & serial number)
57	———	Slidewire resistance element (order by instrument model & serial number)
58	310456-00-2	Slidewire cover
59	310416-00-0	#6-40 Shoulder screw
60	310380-00-6	#8-32 x 5/8" Hex socket-head cap screw
	235338-00-1	Shakeproof washer
61	310389-00-3	Sheave
62	231427-00-0	#6-40 x 5/16" Fillister-head screw
	279008-00-7	Lockwasher
63	282400-00-1	#6-40- x 1/8" Cup-point setscrew
64	310429-00-5	Forward pulley bracket (left carriage)
65	261241-00-1	Spring
	310452-00-7	Tube 3/4" (short)
66	221104-00-3	Mounting screw #4-40 x 5/16"
67	268345-00-7	#6-40 x 3/16" Special-head screw
68	———	Scale (specify instrument model and serial number & input range)
69	310445-00-0	Pen lifter (lower)
70	212366-00-9	Spring
	310483-00-0	Tube 1" (long)
72	310425-00-0	Spring
73	310415-00-4	Lever (L.H.)
74	310417-00-7	#10-32 x 1/2" Oval-point setscrew
75	310443-00-8	Pin (chart drive)
77	310422-00-0	Bracket
	310424-00-3	Plate
78	342338-00-5	Chart drive mechanism (see breakdown in fig. 6)
79	310421-00-4	Chassis latch (L.H.)
80	310423-00-7	Stop
81	310426-00-6	Latch spring
82	258073-00-4	#6-40 x 7/16" Fillister-head screw
	243040-00-8	Shakeproof washer
83	304075-00-0	Terminal block (6 point)
84	310877-00-8	Terminal cover
85	249767-00-7	Post
87	310444-00-4	Shaft pivot
88	285853-00-7	#6-40 x 1/4" Cup-point setscrew
89	342340-00-0	Rear frame
90	310377-00-5	Card only (interchangeable)
	———	Spool card complete (specify instrument model, and serial number & input range.)
91	310378-00-1	Terminal block (14 point)
92	274929-00-7	4-48 x 3/8" Fillister-head screw
94	310494-00-1	Cover (rear frame)
96	332685-00-4	Chart drive support (L.H.)
97	310418-00-3	Chassis latch complete (R.H.)
98	332684-00-8	Chart drive support (R.H.)
99	263786-00-5	Switch plate (on-off)
100	313509-00-0	Switch (on-off)
101	311494-00-5	Right hand lever arm
103	310849-00-4	Slide bracket
104	310856-00-0	Reservoir assembly for a 1-pen recorder
	310858-00-3	Reservoir assembly for a 2-pen recorder
	312978-00-6	Red ink (1 1/4 oz. bottle)
	312979-00-2	Blue ink (1 1/4 oz. bottle)
106	313633-00-2	Marking strip for #2 pen system
109	319811-00-7	#8-32 x 1/2" Fillister-head screw
	235638-00-5	Shakeproof washer
	202420-00-0	Washer
111	———	#1 Balancing Motor Assembly. Includes worm drive gear (144),coupling unit (143), motor bracket (129) & screws. Order complete assembly by instrument model & serial number.
112	———	Chart drive motor (see breakdown in figure 6)
113	310384-00-1	#6-32 x 5/8" Oval-point setscrew
114	———	Change gears (see breakdown in tables A,B & C)

ITEM	PART NUMBER	DESCRIPTION
115	332646-00-9	Motor bracket
116	240747-00-3	#6-40 x 1/8" Fillister-head screw
	279008-00-7	Lockwasher
117	219890-00-5	#2 Hex nut
	268791-00-7	Lockwasher
118	304527-00-9	Pulley
119	303263-00-8	#2-64 x 3/8" Fillister-head screw
120	212016-00-8	#4-48 x 3/16" Flat-head screw
121	302734-00-7	#6-40 x 1/4" Special-head screw
	243040-00-8	Shakeproof washer
	221252-00-2	Washer
122	310381-00-2	Stop (strap complete) for #1 pen mechanism
123	310391-00-8	Stop (L.H.) #1 pen for #1 pen mechanism
124	210626-00-3	#4-48 x 1/8" Fillister-head screw
125	310392-00-4	Cord clamp
126	310484-00-6	Spring for drive cord
127	310411-00-9	#10-32 x 1 3/4" Hex-socket cap screw
	234078-00-6	#10 Lockwasher
128	351434-00-3	Back
129	333514-00-9	Balancing motor bracket
	312556-00-4	Balancing motor bracket (12 sec. only)
130	241463-00-9	#6-32 x 5/16" Hex nut
	243040-00-8	Shakeproof washer
132	310888-00-8	Marking strip for #1 pen system
133	310487-00-5	Cord complete for #2 pen drive
134	310863-00-1	Ink supply tube for 2-pen instrument
	382200-04-7	Ink supply tube (short) for 2-pen instrument
135	310492-00-9	Indicator #2 position
136	313242-00-3	Pen #2
137	310866-06-6	Indicator bracket for #2 pen
138	310897-00-9	Pen guide assembly for #2 pen
139	310481-00-7	Clutch hub for #2 pen
140	310496-00-4	Stop strap complete) for #2 pen mechanism
141	310480-00-0	Stop (R.H.) for #2 pen mechanism
142	———	#2 Balancing Motor Assembly. Includes worm drive gear (144), coupling unit (143) motor bracket (129) & screws. Order complete assembly by instrument model & serial number.
143	310406-00-5	Coupling unit (used only on instruments with a 12-second pen speed)
144	304567-00-0	Worm drive gear for 1-second pen speeds.
	301881-00-6	Worm drive gear for 5-second pen speeds.
145	———	Amplifier for #2 pen mechanism (order by model & serial number) NOTE 1.
146	304573-00-0	Resistor (found only on 50Hz instruments)
147	295698-00-4	Capacitor (found only on 50Hz instruments)

NOTE 1. The amplifier supplied with recorder may differ from type illustrated.

ACCESSORY GROUP OF PARTS

A207	Accessory Group for 1-pen models
A208	Accessory Group for 2-pen models
310359-00-7	Chart tube
310353-00-9	Right-hand hub end for takeup spool
310357-00-4	Left-hand hub end for takeup spool
313660-00-0	Pair of hub ends for feed spool
308807-00-6	Pen cleaner
310937-00-0	Toggle bolts for panel mounting
303880-00-7	3/4" Open end wrench
271061-00-6	1/8" Open end wrench
S-060	Spline key for #4 Setscrew
S-072	Spline key for #6 Setscrew
S-111	Spline key for #10 setscrew
964	Hex key for #8 Cap screw
564	Hex key for #6 Button-head cap screw
532	Hex key for #10 cap screw
18	Hex key for #10 Button-head cap screw
311415-00-8	Special key for #2 cap screw
382476-16-6	1 oz. Bottle of red ink
382476-17-4	1 oz. Bottle of blue ink (only included with 2-Pen models)

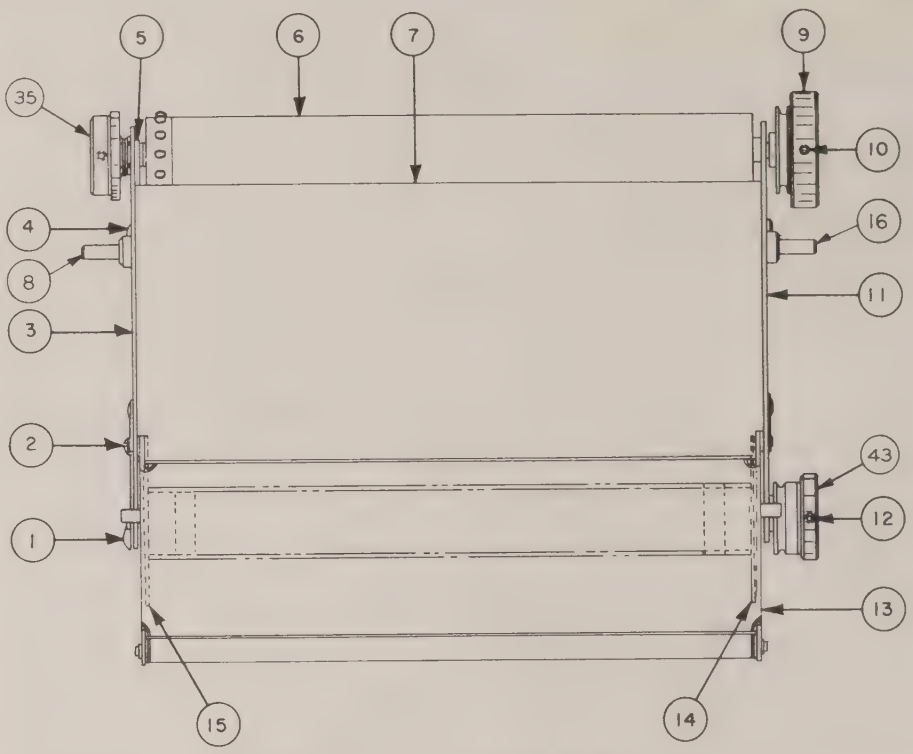

FIGURE 6 FRONT OF CHART DRIVE

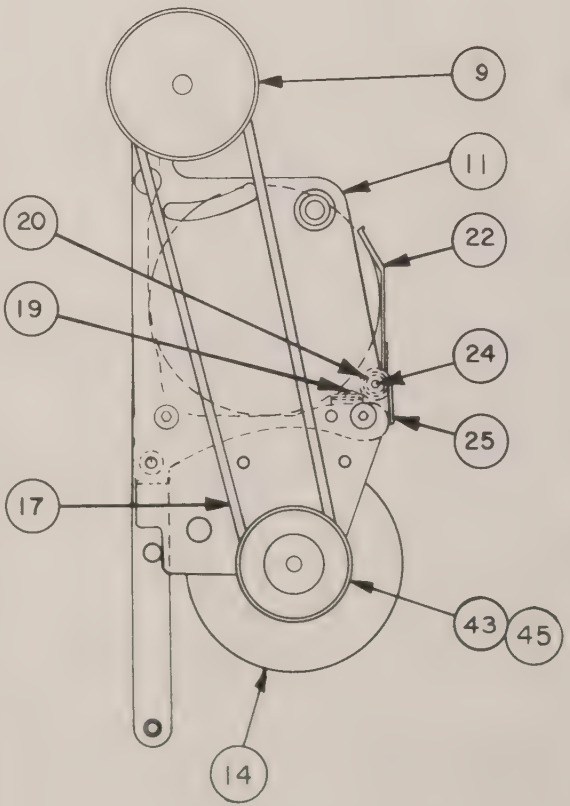

FIGURE 7 RIGHT SIDE OF CHART DRIVE

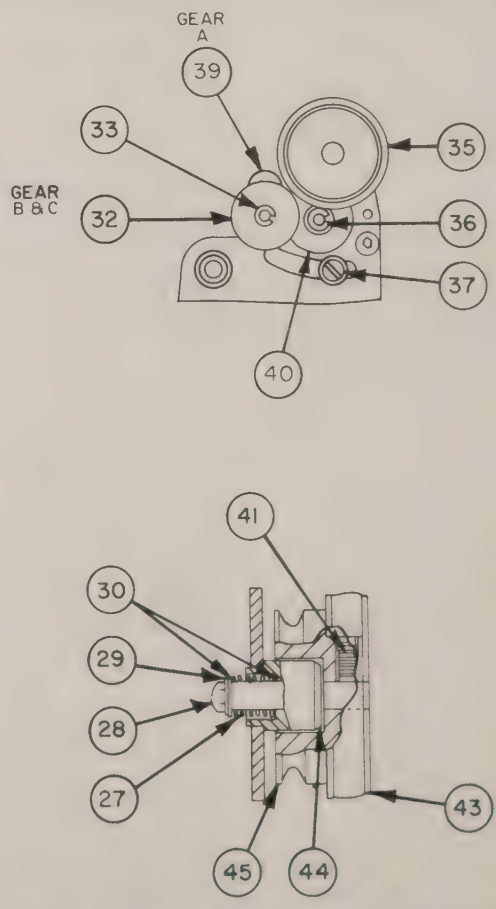

FIGURE 8 CHANGE GEAR & CLUTCH KNOB ASSEMBLY

Breakdown of Chart Drive Mechanism

(refer to page 8 for illustrations)

ITEM	PART NUMBER	DESCRIPTION
1	310352-00-2	Takeup roll positioning plate
2	268345-00-7	#6-40 x 1/8" Special-head screw
3	310327-00-8	Left hand side plate (includes item 46)
4	310329-00-0	Button-head socket shoulder screw
5	310335-00-0	Bracket
6	310330-00-9	Drive roll (aluminum type) complete with sprocket wheel & shaft
	311967-00-0	Drive roll (rubber type) complete with sprocket wheel & shaft
7	332636-00-3	Chart drive body
8	310324-00-9	Left hand catch (part of item 3)
9	310348-00-5	Combination Knurled Knob & pulley for drive roll
10	282403-00-0	#6-40 x 1/8" Flat-point setscrew
11	310322-00-6	Right hand slide plate (includes item 16)
12	282403-00-0	#6-40 x 1/8" Flat-point setscrew
13	332638-00-6	Bracket
14	310353-00-9	Right-hand hub for takeup spool
15	310357-00-4	Left-hand hub for takeup spool
16	310324-00-9	Right-hand catch (part of item 11)
17	310367-00-0	Spring drive belt
19	268345-00-7	#6-40 x 3/16" Special-head screw
20	294410-00-7	"E" ring
22	342343-00-9	Tension guide for feed spool
24	310351-00-6	Shaft
25	307338-00-2	Spring
27	307343-00-6	Spring
28	310360-00-5	Pin
29	292268-00-9	"E" ring
30	307350-00-2	Washer
32	310342-00-7	Change Gear Assy. (B & C combined to form double gear) * -Top 48-tooth gear is B; bottom 24-tooth gear is C-
33	307325-00-8	"E" ring * Ratio of gears is fixed for all models.
35	310345-00-6	Clutch assembly (includes hub clutch, locknut, setscrew, gear & washer)
36	307325-00-8	"E" ring
37	218339-00-3	#6-40 x 3/16" Fillister-head screw
	243040-00-8	Washer
39	_____	Motor pinion "Gear A" (select replacements from tables A, B or C)
40	310338-00-0	Idler gear complete
41	294041-00-1	#4-48 x 1/8" Flat point setscrew
43	310369-00-2	Knob
44	307344-00-2	Washer
45	310361-00-1	Takeup pulley assembly (includes knurled knob & clutch)

CHART DRIVE MOTORS						CHANGE GEARS			
2 RPM 120 V. 60 CYC. 310497-00-0	2 RPM 120 V. 50 CYC. 311730-00-0	8 RPM 120 V. 60 CYC. 313629-00-5	8 RPM 120 V. 50 CYC. 313630-00-3	8 RPH 120 V. 60 CYC. 310394-00-7	8 RPH 120 V. 50 CYC. 311732-00-3	GEAR	TEETH	PITCH	PART NUMBER
CHART SPEED INCHES/MIN.				CHART SPEED INCHES/HR.					
3/16	3/16	3/4	3/4	3/4	3/4	A B*	12 48	64 64	310402-00-0 310342-00-7
1/4	1/4	1	1	1	1	A B*	16 48	64 64	310399-00-9 310342-00-7
3/8	3/8	1 1/2	1 1/2	1 1/2	1 1/2	A C*	12 24	64 64	310402-00-0 310342-00-7
1/2	1/2	2	2	2	2	A C*	16 24	64 64	310399-00-9 310342-00-7
3/4	3/4	3	3	3	3	A B*	48 48	64 64	310398-00-2 310342-00-7
1	1	4	4	4	4	A B*	64 48	64 64	310395-00-3 310342-00-7
1 1/2	1 1/2	6	6	6	6	A C*	48 24	64 64	310398-00-2 310342-00-7
2	2	8	8	8	8	A C*	64 24	64 64	310395-00-3 310342-00-7

TABLE A CHART DRIVE MOTORS & CHANGE GEAR COMBINATIONS FOR SINGLE SPEED RECORDERS

*Gears B & C are combined to form a double gear.

NOTE: MULTIPLE POINT RECORDERS.

For 2-RPM, 60 cy. omit chart drive motor 310497-00-0 and substitute with motor 312507-00-3

For 2-RPM, 50 cy. omit chart drive motor 311730-00-0 and substitute with motor 313542-00-7

For 8-RPH, 60 cy. omit chart drive motor 310394-00-7 and substitute with motor 312508-00-0

For 8-RPH, 50 cy. omit chart drive motor 311732-00-3 and substitute with motor 313543-00-3

CHART DRIVE MOTORS			CHANGE GEARS			
8 RPM 120V.60HZ 313813-00-0 DOUBLE TORQUE	8 RPM 120V.60HZ 313629-00-5	8 RPH 120V.60HZ 310394-00-0	GEAR POSITION	NO. TEETH	PITCH	PART NO.
CHART SPEED						
IN/MIN.	IN/MIN.	IN/HR.				
———	3/4	3/4	A B	12 48	64 64	310402-00-0 310342-00-7
———	1	1	A B	16 48	64 64	310399-00-9 310342-00-7
———	1 1/2	1 1/2	A B	12 24	64 64	310402-00-0 310342-00-7
———	2	2	A B	16 24	64 64	310399-00-9 310342-00-7
———	3	3	A B	48 48	64 64	310398-00-2 310342-00-7
4	———	4	A B	64 48	64 64	310395-00-3 310342-00-7
6	———	6	A B	48 24	64 64	310398-00-2 310342-00-7
8	———	8	A B	64 24	64 64	310395-00-3 310342-00-7

TABLE B MOTORS & CHANGE GEARS FOR FOUR SPEED CHART DRIVES

	TRANSMISSION PART NO. 333377-00-1												CHANGE GEARS			
	2:1 RATIO W.D.850336-02-3		2:1 RATIO W.D.850336-04-0		2:1 RATIO W.D.850336-05-8		4:1 RATIO W.D.850336-06-6		4:1 RATIO W.D.850336-01-5		8:1 RATIO W.D.850336-03-1		GEAR	TEETH	PITCH	PART NUMBER
	CHART SPEED INCHES PER HOUR															
	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW				
MOTOR P/N 313813-00-0	480	240	240	120	120	60	240	60	480	120	480	60	A C	64 24	64 64	310395-00-3 310342-00-7
	360	180	180	90	90	45	180	45	360	90	360	45	A C	48 24	64 64	310398-00-2 310342-00-7
	240	120	120	60	60	30	120	30	240	60	240	30	A B	64 48	64 64	310395-00-3 310342-00-7
MOTOR P/N 313629-00-5	180	90	90	45	45	22-1/2	90	22-1/2	180	45	180	22-1/2	A B	48 48	64 64	310398-00-2 310342-00-7
	120	60	60	30	30	15	60	15	120	30	120	15	A C	16 24	64 64	310399-00-9 310342-00-7
	90	45	45	22-1/2	22-1/2	11-1/4	45	11-1/4	90	22-1/2	90	11-1/4	A C	12 24	64 64	310402-00-0 310342-00-7
	60	30	30	15	15	7-1/2	30	7-1/2	60	15	60	7-1/2	A B	16 48	64 64	310399-00-9 310342-00-7
	45	22-1/2	22-1/2	11-1/4	11-1/4	5-5/8	22-1/2	5-5/8	45	11-1/4	45	5-5/8	A B	12 48	64 64	310402-00-0 310342-00-7

TABLE C CHANGE GEAR COMBINATION FOR TWO-SPEED CHART DRIVES (TD84D)

	TRANSMISSION PART NO. 333388-00-3										CHANGE GEARS			
	6:1 RATIO W.D.850336-01-5		6:1 RATIO W.D.850336-06-6		10:1 RATIO W.D.850336-02-3		10:1 RATIO W.D.850336-05-8		60:1 RATIO W.D.850336-03-1		GEAR	TEETH	PITCH	PART NUMBER
	CHART SPEED INCHES PER HOUR													
	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW				
MOTOR P/N 313813-00-0	480	80	48	8	480	48	80	8	480	8	A C	64 24	64 64	310395-00-3 310342-00-7
	360	60	36	6	360	36	60	6	360	6	A C	48 24	64 64	310398-00-2 310342-00-7
	240	40	24	4	240	24	40	4	240	4	A B	64 48	64 64	310395-00-3 310342-00-7
MOTOR P/N 313629-00-5	180	30	18	3	180	18	30	3	180	3	A B	48 48	64 64	310398-00-2 310342-00-7
	120	20	12	2	120	12	20	2	120	2	A C	16 24	64 64	310399-00-9 310342-00-7
	90	15	9	1-1/2	90	9	15	1-1/2	90	1-1/2	A C	12 24	64 64	310402-00-0 310342-00-7
	60	10	6	1	60	6	10	1	60	1	A B	16 48	64 64	310399-00-9 310342-00-7
	45	7-1/2	4-1/2	3/4	45	4-1/2	7-1/2	3/4	45	3/4	A B	12 48	64 64	310402-00-0 310342-00-7

TABLE C CONT'D. CHANGE GEAR COMBINATIONS FOR TWO-SPEED CHART DRIVES (TD84D)

NOTE: 1. Gear B & C are combined to form a double gear.

2. Speeds are determined not only by the gears used but also by the way the motor is wired.

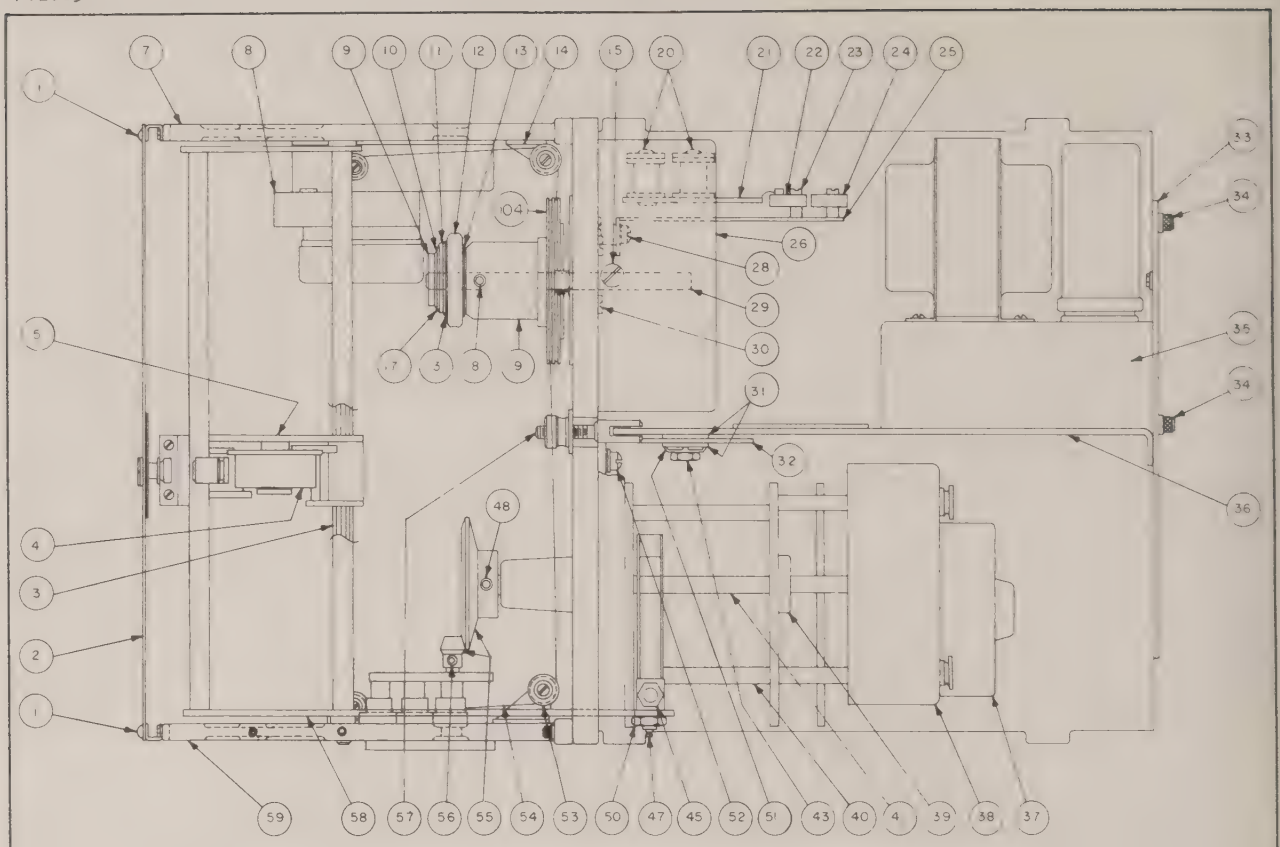

FIGURE 9. TOP VIEW OF MULTIPLE PRINT CHASSIS

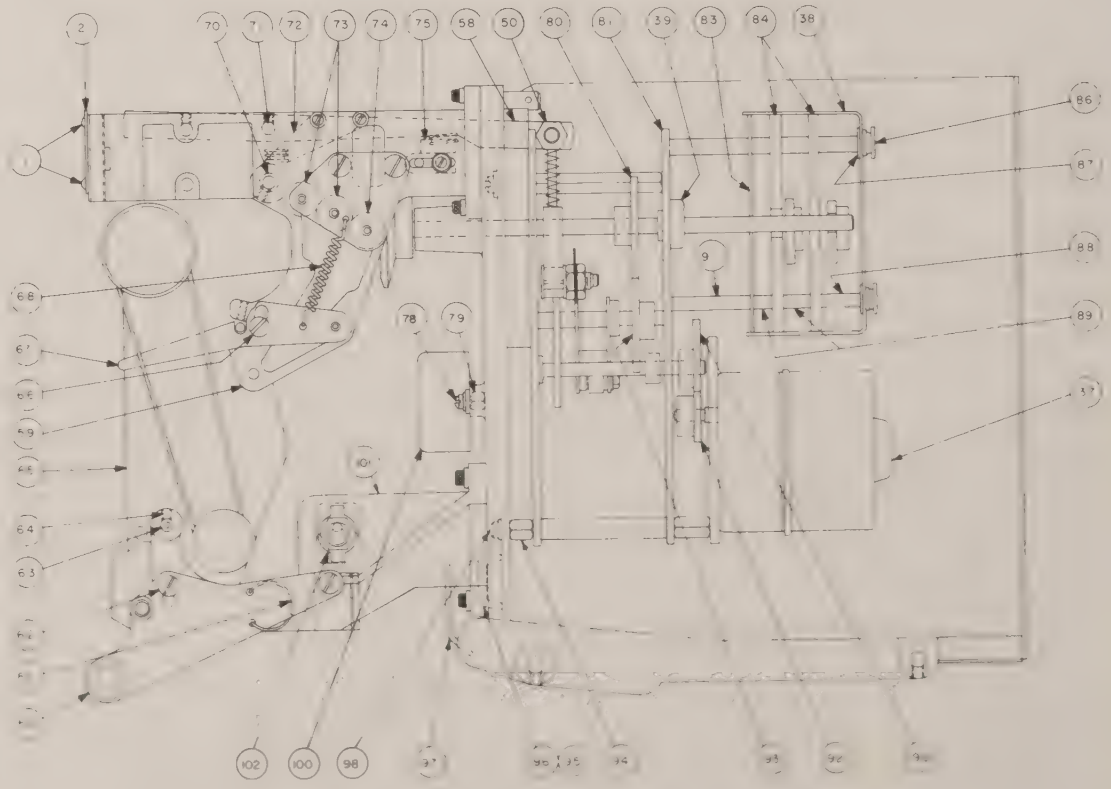

FIGURE 10. LEFT VIEW OF MULTIPLE PRINT CHASSIS

THIS BREAKDOWN COVERS MULTIPLE PRINT DYNAMASTER RECORDERS

ITEM	PART NUMBER	DESCRIPTION
1	268345-00-7	Special head screw, #6-40 x 3/16"
2	———	Scale - (order by instrument model & serial number)
3	311951-00-7	Spline shaft
4	———	Felt holder wheel (see breakdown in figure 16)
5	———	Printing assembly (see breakdown in figure 14)
7	333387-00-7	Left hand printer carriage bracket complete -includes the following items which are not illustrated:
	310425-00-0	Spring
	310412-00-5	Lever Arm
	311972-00-4	Fwd. Pulley & Bracket Assembly
	311976-00-0	Rear Pulley & Bracket Assembly
8	———	Chart drive mechanism (see breakdown in figure 6)
9	303874-00-7	Slotted nut, 1/2 x 27
10	279235-00-3	Washer
11	275854-00-0	Washer
12	304566-00-4	Potentiometer worm wheel for 1-sec. balancing speeds
	310882-00-1	Potentiometer worm wheel for 5-sec. balancing speeds
13	312705-00-0	Clutch washer
14	310430-00-3	Left hand pulley bracket
15	310416-00-0	Shoulder screw #6-40
17	315414-00-6	Spring washer
18	304414-00-0	Flat point screw, #8-32 x 3/16"
19	310387-00-0	Clutch hub
20	———	Spool resistances (see figure 3 for common parts)
21	———	Spool card (see figure 3 for common parts)
22	310378-00-1	Terminal Block - 14 pts.
23	274929-00-7	#4-48 x 3/8" Fillister-head screw
24	———	Trimmer potentiometer (see figure 3 for common parts)
25	313373-00-0	Mounting bracket complete
28	240067-00-2	#8-32 x 3/8" Fillister-head screw
	235638-00-5	Shakeproof washer
29	310385-00-8	Shaft complete
30	302734-00-7	Special-head screw #6-40 x 1/4"
31	310453-00-3	Washer
32	310454-00-0	Door stop complete
33	310461-00-6	Gusset (rear)
34	310455-00-6	Hex head screw #8-32 x 5/16"
35	———	Amplifier (see separate parts list for amplifier)
36	332657-00-0	Partition compartment (includes item 57)
37	———	Motor for Multiple Print Drive Mechanism (see breakdown in figure 11)
38	288145-00-3	Switch cover
39	288086-00-7	Bearing housing
40	———	Multiple Print Drive Mechanism. Shown with gearing cut away (see breakdown in figure 11).
41	312103-00-0	Switch shaft
43	382281-01-2	Screw, door stop
45	282647-00-7	Elastic nut
47	288081-00-5	Yoke assembly for depressor bar
48	282415-00-9	Cup-point screw #10-32 x 1/4"
50	295913-00-2	Nut
	288083-00-8	Washer
51	261812-00-9	Spring washer
52	309811-00-7	#8-32 x 1/2" Fillister-head screw
	235638-00-5	Shakeproof washer
53	310431-00-0	Right-hand pulley bracket
54	311961-00-2	Cord complete
55	311958-00-1	Bevel gear set
56	282400-00-1	Cup-point setscrew #6-40 x 1/8"
57	216253-00-4	Thumb nut
	310453-00-3	Washer
	310499-00-3	Spring
58	333309-00-6	Depressor bar
59	333367-00-6	Right-hand printer carriage bracket complete - includes items 64, 66, 68, 72, 73, 74 & 75.

ITEM	PART NUMBER	DESCRIPTION
60	310408-00-3	Chassis latch, right-hand (see figure 3 for left-hand chassis latch)
61	310426-00-6	Latch spring
62	310416-00-0	Shoulder screw #6-40
63	310443-00-8	Pin (Chart Drive)
64	282400-00-1	#6-40 x 1/8" Cup-point setscrew
65	342338-00-5	Chart drive mechanism (see breakdown in figure 6)
66	310416-00-0	Shoulder screw #6-40
67	310412-00-5	Lever, right-hand
68	310425-00-0	Spring
70	311952-00-3	Journal
71	310404-00-4	Guide rod
72	311971-00-8	Fwd. Pulley & Bracket Assembly
73	311990-00-2	Idler gear
74	311994-00-8	Gear
75	311976-00-0	Rear pulley & bracket assembly
78	239770-00-5	#6-40 x 1/4" Fillister-head screw
79	249767-00-1	Post
80	———	Switch shaft gear (see breakdown in figure 11)
81	———	Multiple print drive mechanism (see breakdown in figure 11)
83	288067-00-2	Switch base
84	298011-00-0	Switch (multiple unit)
	298013-00-2	Contact arm for switch
86	255785-00-3	Special thumb screw #10-32
87	282381-00-7	Washer
88	288070-00-3	Post
89	288068-00-9	Post
		Motor (see breakdown in figure 11)
90	———	Gear (see breakdown in figure 11)
91	288144-00-7	Post
92	———	Motor pinion gear (see breakdown in figure 11)
93	———	Ratchet shaft gear (see breakdown in figure 11)
94	312110-00-6	Post
95	310888-00-0	Marking strip.(servomotor side)
	313684-00-6	Marking strip (multiple mechanism side)
96	304075-00-0	Terminal block - 6 pt.
	239770-00-5	#6-40 x 1/4" Fillister-head screw (not shown)
	301998-00-0	Post (not shown)
	221252-00-2	Washer (not shown)
97	310887-00-8	Terminal cover
98	303886-00-5	#10-32 x 5/16" Fillister-head screw
	235638-00-5	Shakeproof washer #10
100	290059-00-3	Capacitor
101	332684-00-8	Chart drive support - right-hand
	332685-00-4	Chart drive support - left-hand (not shown)
102	313509-00-0	Switch
	263786-00-5	On-off plate
104	310389-00-3	Sheave

ACCESSORY GROUP OF PARTS

FOR

MULTIPLE PRINT RECORDERS

PART NUMBER	DESCRIPTION
A-211	Accessory Group for 2-point, 2-color models
A-212	Accessory Group for 3-point, 3-color models
A-213	Accessory Group for 4-point, 4-color models
A-214	Accessory Group for 12-point, 6-color models
A-215	Accessory Group for 6-point, 8-point and 12-point, single color models
A-216	Accessory Group for 12-point, 4-color models
A-217	Accessory Group for 12-point, 3-color models
310359-00-7	Chart tube
310353-00-9	Right-hand hub end for takeup spool
310357-00-4	Left-hand hub end for takeup spool
313660-00-0	Pair of hub ends for feed spool
310937-00-0	Toggle bolts for panel mounting
303880-00-7	3/4" Open end wrench
271061-00-6	1/8" Open end wrench
S-060	Spline key for #4 setscrew
S-072	Spline key for #6 setscrew
S-111	Spline key for #10 setscrew
332	Hex key for #8 cap screw
564	Hex key for #6 button-head cap screw
532	Hex key for #10 cap screw
18	Hex key for #10 button-head cap screw
311415-00-8	Special key for #2 cap screw
———	Inking felts (see item 29 on page 19 for complete listing)

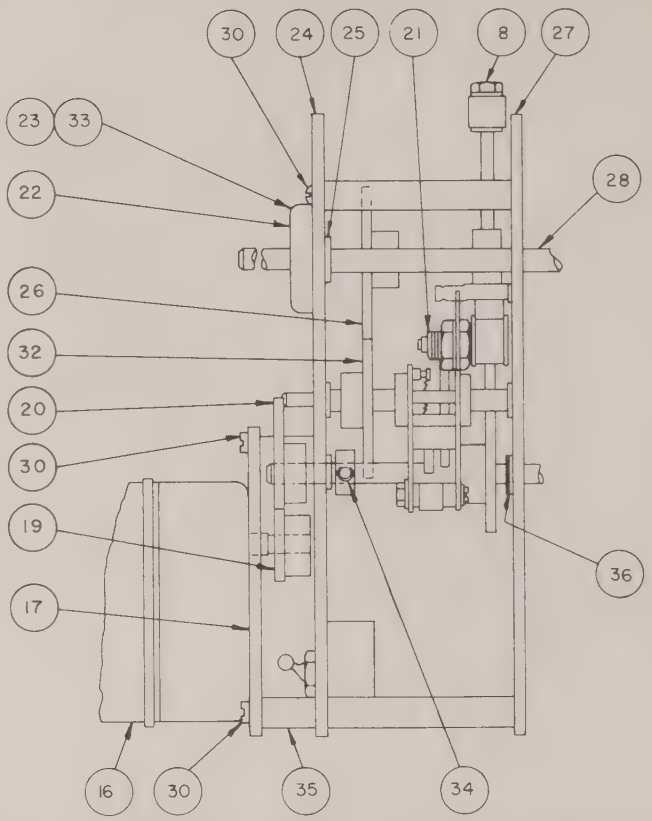

FIGURE 11. LEFT SIDE OF MULTIPLE PRINT DRIVE MECHANISM

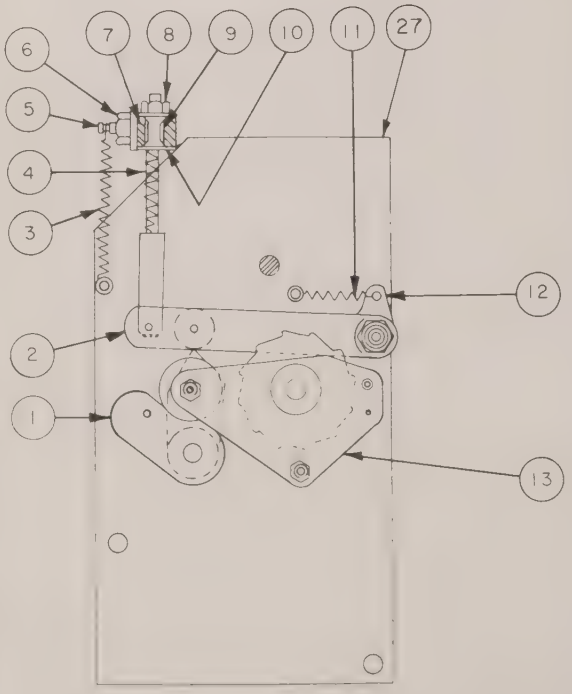

FIGURE 12. REAR OF FRONT PLATE

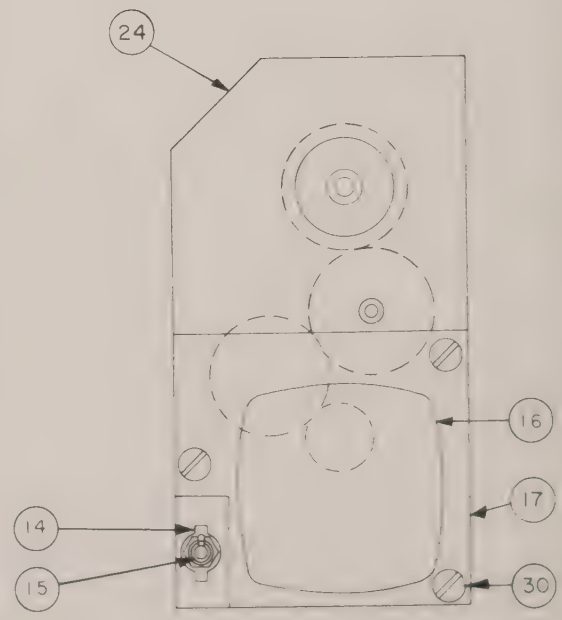

FIGURE 13. REAR OF BACK PLATE

BREAKDOWN OF MULTIPLE PRINT DRIVE MECHANISM
(Refer to illustrations on page 16)

ITEM	PART NO.	DESCRIPTION
	342906-00-3	Multiple Print Drive Mechanism (minus gearing, motor & switch)
1	315441-00-3	Cam shaft and lever complete
2	333306-00-7	Printing lever complete
3	312102-00-3	Printing lever spring
4	288080-00-9	Printing pressure spring
5	288081-00-5	Depressor yoke
6	289653-00-2	Depressor yoke nut
7	288083-00-8	Yoke washer
8	282647-00-7	6-40 Self-locking nut
9	295913-00-2	Sleeve
10	288082-00-1	Spring collar
11	288032-00-4	Latch lever spring
12	295556-00-5	Latch lever complete
13	298027-00-3	Ratchet shaft and pawl lever complete
14	263786-00-5	Switch plate
15	305288-00-8	Power switch
16	———	Motor (select proper type from list below)
	296738-00-0	Motor, 120 volt, 50-60 cycle for 60-second print interval
	288060-00-8	Motor, 120 volt, 50-60 cycle for 8-, 15-, 30-second print interval
	292128-00-2	Motor, 120 volt, 50-60 cycle for 1.9-, 3.9-second print interval
	290059-00-3	Capacitor for motor (not shown)
17	312106-00-9	Motor mounting plate
19	———	Motor pinion (select proper type from list below)
	292129-00-9	(46T - 48P) for 8-second print interval
	294261-00-1	(22T - 48P) for 3.9- or 60-second print interval
	288061-00-4	(19T - 48P) for 30-second print interval
	289150-00-0	(36T - 48P) for 15-second print interval
	294460-00-4	(37T - 48P) for 1.9-second print interval
	282413-00-6	10-32 x 3/16" Bristo flat-point setscrew for item 19.
20	———	Gear, including setscrew (select proper type from list below)
	292131-00-3	(62T - 48P) for 8-second print interval
	294263-00-4	(86T - 48P) for 3.9-, or 60-second print interval
	288014-00-6	(89T - 48P) for 15- or 30-second print interval
	294462-00-7	(71T - 48P) for 1.9-second print interval
	282413-00-6	10-32 x 3/16" Bristol flat-point setscrew for item 20.
21	279854-00-5	Waldes Tru-arc retaining ring
22	288037-00-6	#4-48 x 3/8" Flat-head screw
23	288086-00-7	Bearing housing
24	333307-00-3	Back plate complete
25	291015-00-0	Retaining ring
	261381-00-8	Thrust washer
26	———	Switch shaft gear (select proper type from list below)
	312104-00-6	(60T - 48P) 2, 3 or 6-point intrument
	312105-00-2	(60T - 48P) 4, or 8-point instrument
	286076-00-4	(75T - 48P) 12-point instrument
27	333305-00-0	Front plate complete
28	312103-00-0	Switch shaft
29	266539-00-9	10-32 x 1/2" Fillister-head screw
	235638-00-5	#10 Shakeproof washer
30	253732-00-0	Shoulder screw #6-40
	226966-00-3	Nut
	228453-00-2	Washer
32	———	Ratchet shaft gear (select proper type from list below)
	288037-00-6	(100T - 48P) for 2, 3 or 6-point instrument
	288072-00-6	(90T - 48P) for 4 or 8-point instrument
	286076-00-4	(75T - 48P) for 12-point instrument
33	288085-00-0	Switch shaft bearing
34	244791-00-7	Collar
	305904-00-0	6-40 x .110 Setscrew
35	312108-00-1	Post
36	310895-00-6	Retaining ring

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

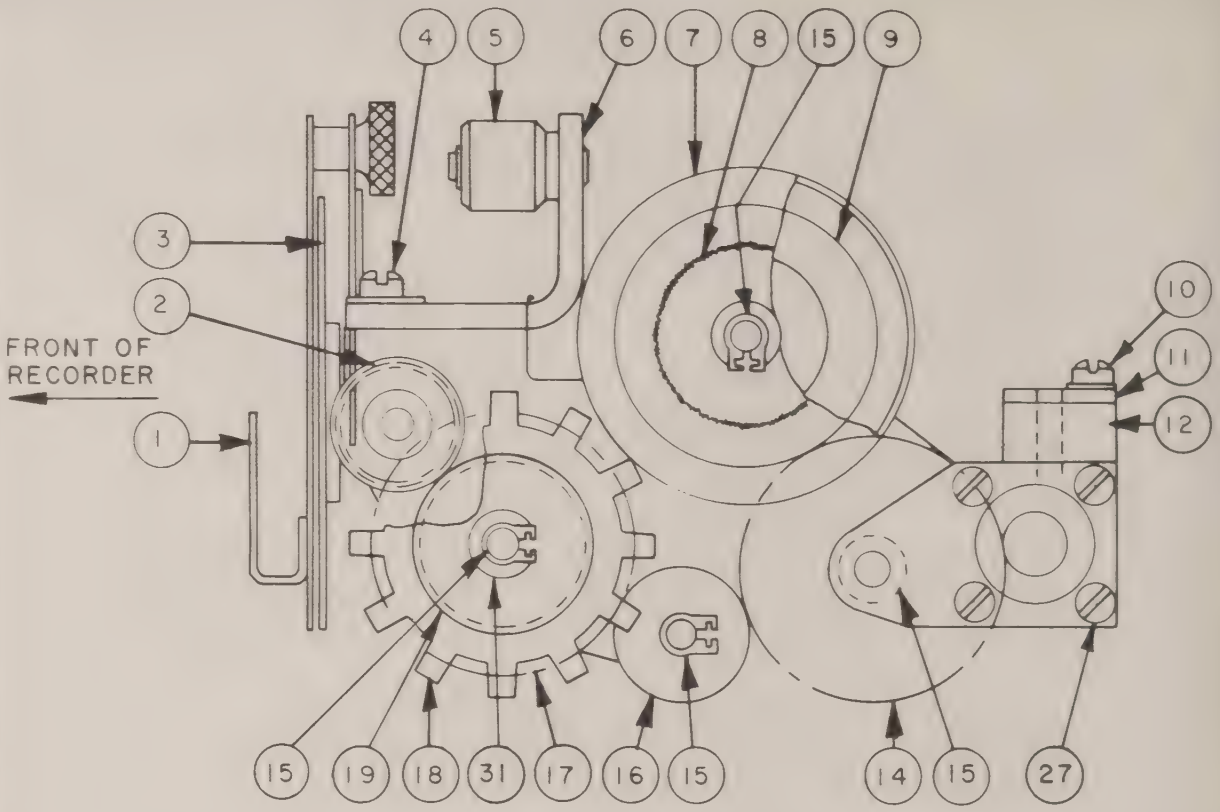

FIGURE 14. PRINTING ASSEMBLY

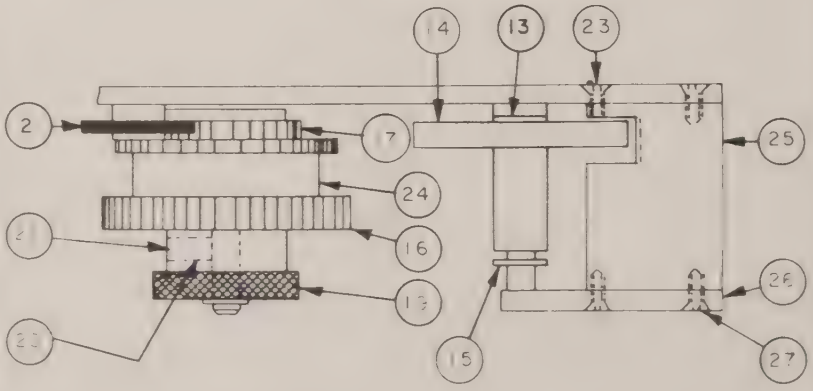

FIGURE 15. TOP VIEW OF PRINTING ASSEMBLY
(UPPER HALF CUT AWAY)

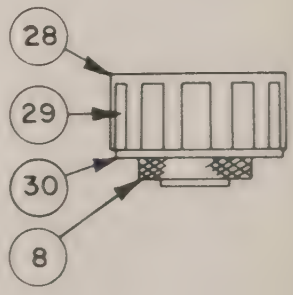

FIGURE 16. FELT WHEEL HOLDER
(MULTI COLOR)

BREAKDOWN OF PRINTING ASSEMBLY
(Refer to illustrations on page 18)

ITEM	PART NO.	DESCRIPTION
1	332821-00-5	Shield and pointer assembly
2	309419-00-0	Gear
3	———	Designation Disk (select proper type from table below)

312146-00-0 - 2 point	312130-00-7 - 6 point
312147-00-7 - 3 point	312119-00-3 - 8 point
312148-00-3 - 4 point	311953-00-0 -12 point

4	265071-00-3	#3-56 x 1/8" Fillister-head screw
5	286070-00-6	Roller complete
6	333300-00-9	Left side plate assembly
7	310561-00-0	Felt holder wheel assembly for single color printing models. Complete assembly includes following items:
	309400-00-7	Felt
	312467-00-1	Washer
	289898-00-5	Nut
8	309411-00-9	Thumb nut
9	314612-00-9	Gear assembly
10	236111-00-0	#4-48 x 7/16" Fillister-head screw
	245692-00-2	#4 Shakeproof washer
11	311981-00-3	Cord clamp
12	311979-00-9	Spacer complete
13	228211-00-0	Washer
14	286072-00-9	Gear assembly
	312468-00-8	Washer
15	280607-00-8	Retaining ring
16	312715-00-5	Gear
17	313146-00-4	Gear assembly
18	———	Type wheel (select proper type from table below)

312136-00-5 - 2 point	312116-00-4 - 6 point
312137-00-1 - 3 point	312113-00-5 - 8 point
312138-00-8 - 4 point	312111-00-2 -12 point

19	309412-00-5	Thumb nut
20	307349-00-4	Nylon pad
21	282404-00-7	#6-40 Flat-head setscrew
23	308312-00-7	#2-64 x 1/8" Flat-head screw
24	309458-00-5	Hub complete
25	311977-00-6	Frame block complete
26	311978-00-2	Plate (right-hand)
27	304770-00-0	#2-64 x 3/16" Fillister-head screw
28	333506-00-6	6-segment felt holder wheel (used in place of item 7 on certain models)
	333507-00-2	8-segment felt holder wheel (used in place of item 7 on certain models)
	333508-00-9	12-segment felt holder wheel (used in place of item 7 on certain models)
29	———	Inking felts (select proper type from table below)

	Black	Red	Purple	Green	Blue	Brown
6-segment	312518-00-5	312519-00-0	312520-00-0	312521-00-6	312522-00-2	312523-00-9
8-segment	312514-00-0	312515-00-6	312516-00-2	312517-00-9		
12-segment	314840-00-1	314841-00-8	314842-00-4	314843-00-0	312512-00-7	312513-00-3

30 ——— Felt holder caps (select proper type from table below)

312786-00-0 - 2 point	312789-00-9 - 6 point
312787-00-6 - 3 point	312790-00-7 - 8 point
312788-00-2 - 4 point	312791-00-3 -12 point

31	314678-00-0	Spacer
	286066-00-9	Spring
	311192-00-9	Teflon washer 3/16"
32	———	Printing Assembly Complete (order by instrument model & serial number)

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

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BRISTOL® instruments

instructions

AUGUST, 1972 P12578

(Replaces Instr. 910121-09-5)

DYNAMASTER®

SERIES "S" AMPLIFIERS

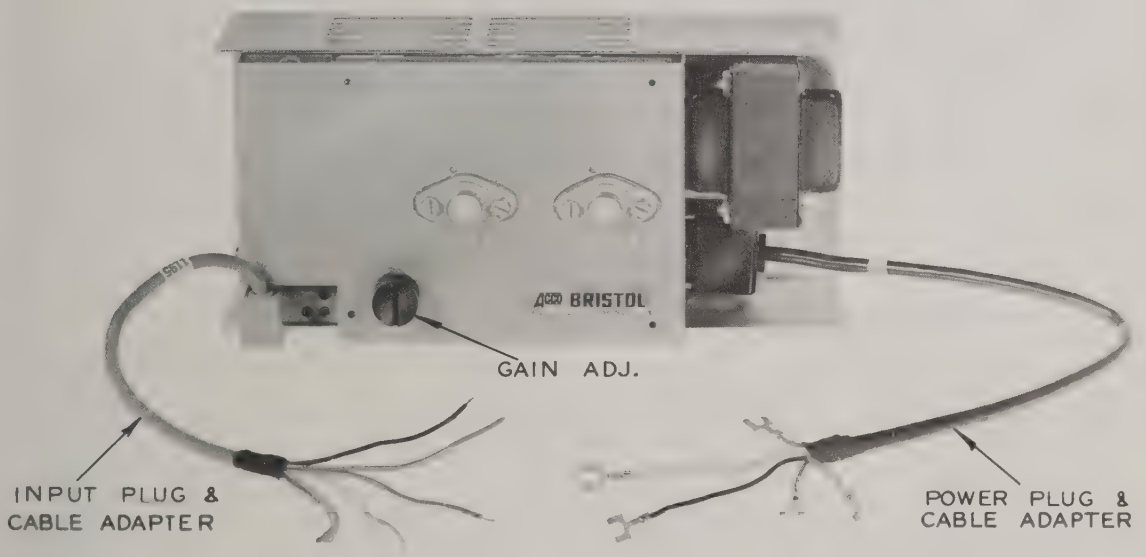

FIGURE 1. SERIES S AMPLIFIER W/ CABLE ADAPTERS

ACCO

Bristol Division

40 BRISTOL STREET, WATERBURY, CONNECTICUT 06720

AMERICAN CHAIN & CABLE COMPANY, INC.

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INTRODUCTION

Series "S" Amplifiers (figure 1) are compact solid state devices designed for use with DYNAMASTER instruments. Essentially these units provide the necessary level of excitation to drive the indicating and balancing mechanism of the instrument. The manner in which this is accomplished is explained in the instrument manual.

Series "S" Amplifiers operate in association with a bridge-type circuit. The bridge, which derives the error signal by comparing the measured variable to a precise reference voltage, is contained separately in the instrument. Some amplifier models will supply the reference voltage to the bridge while others will not. In this latter instance, the reference voltage is provided by an external supply. Amplifiers with the internal reference voltage contain a zener diode regulated circuit. Amplifiers not supplying a d-c reference voltage omit this circuitry.

Amplifier response is controlled by a gain adjustment located on the chassis. However, amplifiers may also be specified with an auxiliary gain feature. Essentially, this feature allows an externally mounted potentiometer to adjust the gain of the amplifier. This feature does not defeat the internal amplifier gain adjustment but, instead, works in conjunction with it.

Series "S" Amplifiers are identified by part number. Table A list the specifications as well as the appropriate schematic drawings for each part number. Make selections accordingly.

THEORY

A. Basic Block Theory

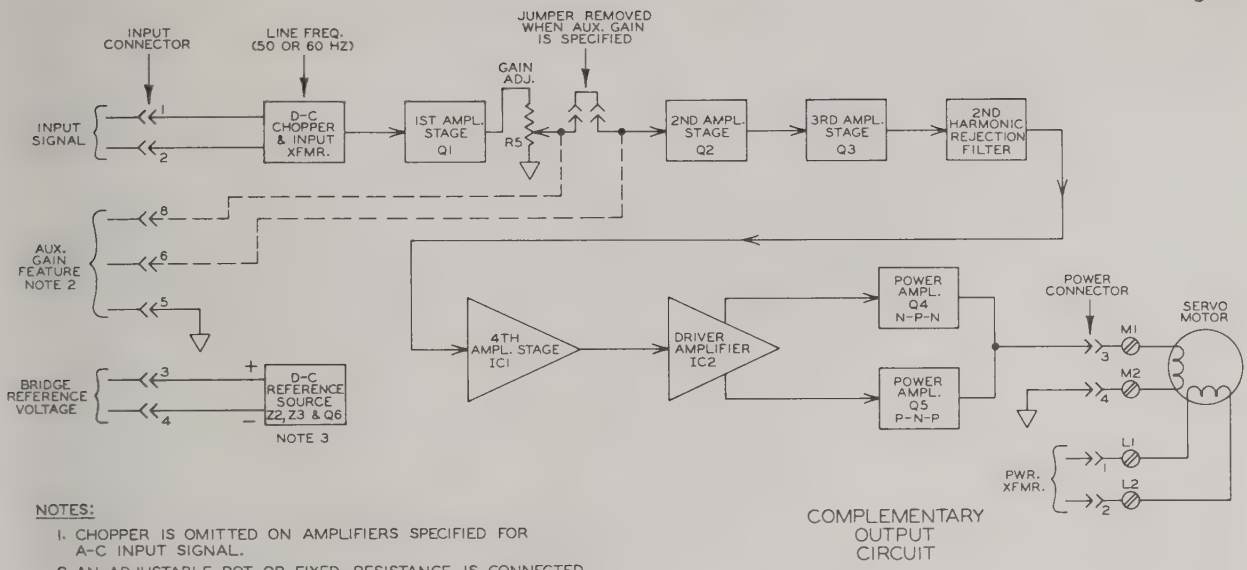
A block diagram of a typical Series "S" Amplifier is illustrated in figure 2. To begin with, the input signal is applied to connector terminals 1 and 2, and is impressed across a d-c chopper and input transformer. The chopper, which interrupts the d-c error voltage at line rate, provides an equivalent chopped, square wave, a-c signal. This signal, amplified by the first amplifier stage, Q1, is impressed across the gain adjustment potentiometer, R5. Subsequent amplification is provided by the second and third amplifier stages (Q2 and Q3).

The rejection filter located at the output of the third amplifier stage removes the second harmonic component of the chopped signal and shapes it into a sinewave. Further amplification of the filtered a-c signal is provided by amplifiers IC1 and IC2. Amplifier IC2, which works in association with complimentary output circuit Q4 and Q5, provides power to drive the control windings of the servo motor (M1 and M2). As such, the servo motor will rotate clockwise or counterclockwise until the bridge circuit is balanced (zero error).

The response of the amplifier to an error signal is controlled by the gain adjustment (R5). However, some amplifiers will contain an auxiliary gain feature to provide external adjustment. In this instance, the jumper located between the first and second amplifier stage is removed and replaced by a three-wire auxiliary gain cable. The external potentiometer is then connected to terminals 8, 6 and 5 of the input connector.

	PART NUMBER	TYPE INPUT SIGNAL	INPUT IMPEDANCE OHMS	REFERENCE VOLTAGE	AUXILIARY GAIN FEATURE	A-C POWER	SCHEMATIC & PICTORIALS
1	374591-10-5	DC	100K	1.0190 VDC	WITHOUT	120V @ 60 HZ	Fig. 3 & 8
2	374591-11-3	DC	100K	1.0190 VDC	WITH	120V @ 60 HZ	Fig. 3 & 8
3	374591-20-2	DC	1K	1.0190 VDC	WITHOUT	120V @ 60 HZ	Fig. 3 & 8
4	374591-21-0	DC	1K	1.0190 VDC	WITH	120V @ 60 HZ	Fig. 3 & 8
5	374592-10-1	DC	100K	1.0190 VDC	WITHOUT	120V @ 50 HZ	Fig. 3 & 8
6	374592-11-0	DC	100K	1.0190 VDC	WITH	120V @ 50 HZ	Fig. 3 & 8
7	374592-20-9	DC	1K	1.0190 VDC	WITHOUT	120V @ 50 HZ	Fig. 3 & 8
8	374592-21-7	DC	1K	1.0190 VDC	WITH	120V @ 50 HZ	Fig. 3 & 8
9	374593-10-8	DC	100K	Ext. DC	WITHOUT	120V @ 60 HZ	Fig. 4 & 9
10	374593-20-5	DC	1K	Ext. DC	WITHOUT	120V @ 60 HZ	Fig. 4 & 9
11	374594-10-4	DC	100K	Ext. DC	WITHOUT	120V @ 50 HZ	Fig. 4 & 9
12	374594-20-1	DC	1K	Ext. DC	WITHOUT	120V @ 50 HZ	Fig. 4 & 9
13	374595-10-0	DC	100K	8.000 VDC	WITHOUT	120V @ 60 HZ	Fig. 3 & 8
14	374595-20-8	DC	1K	Ext. DC	WITHOUT	120V @ 60 HZ	Fig. 5 & 10
15	374595-40-2	AC	1K	Ext. AC	WITHOUT	120V @ 60 HZ	Fig. 6 & 10
16	374596-10-7	DC	100K	8.000 VDC	WITHOUT	120V @ 50 HZ	Fig. 3 & 8
17	374596-20-4	DC	1K	Ext. AC	WITHOUT	120V @ 50 HZ	Fig. 5 & 10
18	374596-40-9	AC	1K	Ext. AC	WITHOUT	120V @ 50 HZ	Fig. 6 & 10

TABLE A. TYPES OF SERIES S AMPLIFIERS



NOTES:

1. CHOPPER IS OMITTED ON AMPLIFIERS SPECIFIED FOR A-C INPUT SIGNAL.
2. AN ADJUSTABLE POT OR FIXED RESISTANCE IS CONNECTED ACROSS 8 AND 6 FOR EXTERNAL GAIN ADJUSTMENT.
3. REFERENCE SOURCE OMITTED WHEN BRIDGE VOLTAGE IS SUPPLIED EXTERNALLY.

FIGURE 2. BLOCK DIAGRAM OF AMPLIFIER

With this arrangement, the gain of the amplifier is influenced by both the internal and external gain potentiometers.

Amplifiers that supply d-c reference excitation for the bridge circuit will contain a d-c reference source circuit composed of zener diodes Z3, Z2 and transistor Q6. This circuit applies the reference voltage to input socket terminals 3 and 4 for external use. The value of the external reference voltage will be as specified in table A.

Bridge circuits that utilize an a-c reference voltage do not require d-c to a-c conversion. Therefore, amplifiers in this category will omit the chopper circuitry. Consequently, the a-c error input signal will be applied directly to the input transformer for amplification by transistor Q1.

The remainder of the amplifier circuitry is unaffected by this change.

B. Detailed Circuit Description

A typical amplifier schematic is contained in figure 3. D-c power for the amplifier is supplied by bridge circuit BR1 which provides an approximate +14 and -14 volt output. The +14 volt supply is filtered by R24, C20, R15, C11, R6 and C5, while the -14 volt supply is filtered by R36 and C25.

The d-c error signal from the bridge circuit is impressed across input socket terminals 1 and 2. This voltage is "chopped" at line rate and appears as a square wave signal across the secondary of the input transformer. Capacitor Ct is used to prevent phase shift of the chopped signal and resistor RL, found on some models, serves to limit the source impedance. Capacitor C1 couples the a-c signal to the base of Q1.

Q1 is a high gain common emitter stage with the base biased by R1 and R2. R3 is the collector load resistor and R4 is the emitter resistor. C2 prevents the entry of high frequency line voltage transients into the base of Q1.

The output of Q1 is coupled through C3 to potentiometer R5, the Gain Adj. The voltage at the center tap of R5 is then coupled through C6 to the gate of Q2, which is a common source J-FET. Resistors R7 and R9 provide the gate bias, while R8 provides

the drain load. R10, the source resistor, is bypassed by C7. Resistor R10A is left unbypassed to lower the gain of this stage.

The output of Q2 is coupled through C8 to the gate of Q3, which is the second J-FET stage. Resistor R12 and R11 provide gate bias, while R13 functions as the drain load. R14, the source resistor, is bypassed by C10. Capacitor C9, connected from drain to source, is used to filter out the components of the signal.

The output of Q3 feeds into a tuned parallel T section composed of R16, R17, R18, R19, R20, C12, C13, and C14. The filter rejects the second harmonic of the chopped signal and provides a more sinusoidal output. The filtered output is coupled through C16, to the non-inverting input of IC-1, the first integrated circuit stage. R22, the load resistor for the filter, also functions as a bias resistor for IC-1.

Resistors R21 and R23, together with capacitors C17 and C18, determine the gain of operational amplifier IC-1. C18 provides phase shifting for the signal, while C17 blocks d-c flow through R21. To achieve bias compensation, R22 is made equal to the junction impedance of R23 and R21.

The filtered a-c signal is coupled through C19 and R25 to the inverting input of IC-2. R28 and C22 form the feedback path which, in conjunction with R25, determines the gain of IC-2. Resistor R34 serves as the load. Drive for the power transistors Q4 and Q5 is taken off of R30 and R35 which are the supply voltage dropping resistors for IC-2. The load for the collectors is the servo motor control field which is shunted by C26. Resistor R29 determines the bias applied to the inverting input of IC-2. Subsequent current flow through R35 turns on Q5 so that approximately 500 ma. flows through the motor. This current produces a strong damping effect on the motor.

The voltage fed back through D6 and R32 to pin 2 of IC-2 also affects the bias at this input. The direction of current through D6 will tend to increase the bias during drive conditions, causing further motor damping.

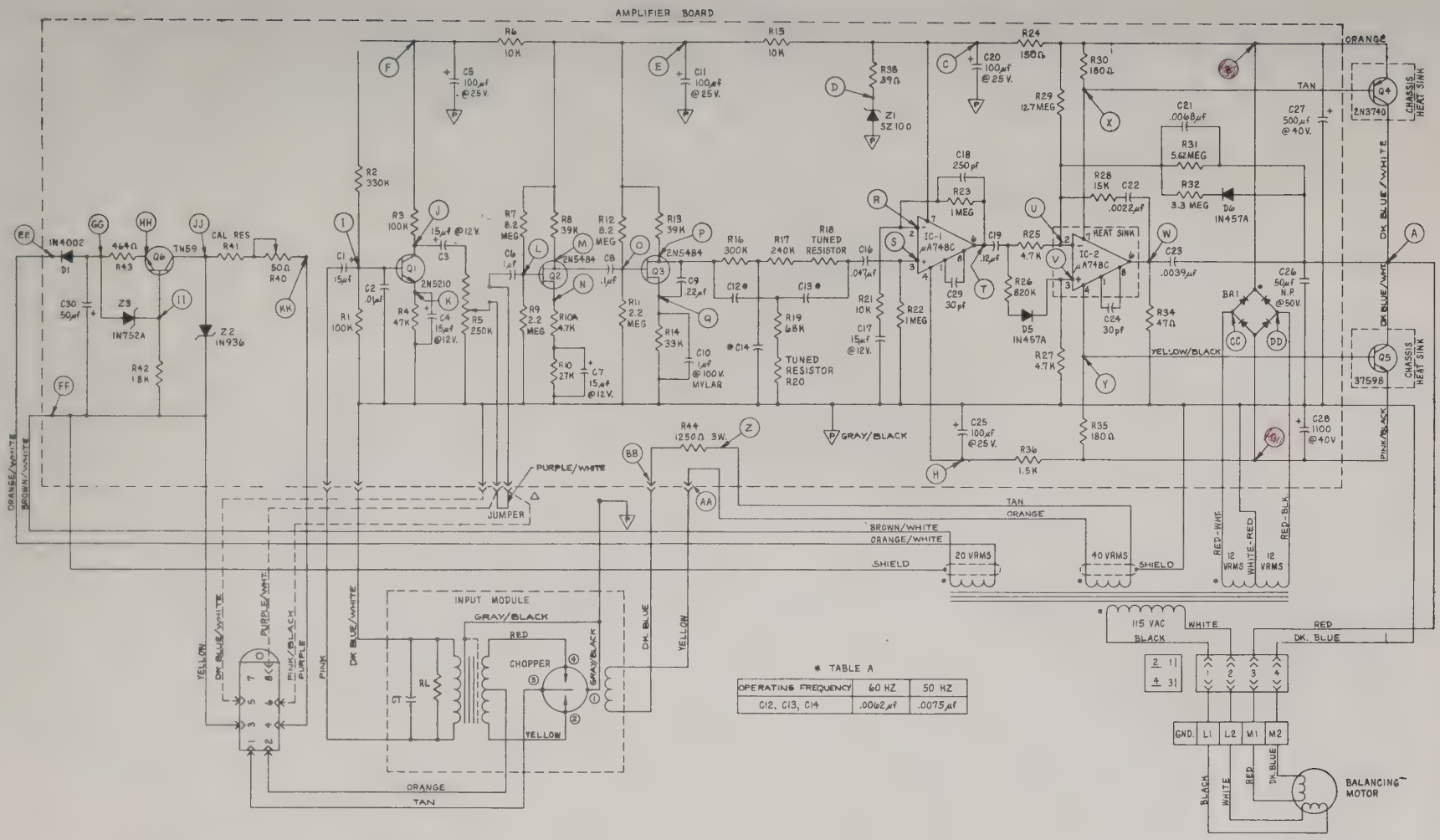
The voltage fed back through D6 and R32 to pin 2 of IC-2 also affects the bias at this input. The direction of current through D6 will tend to increase the bias during drive conditions, causing further motor damping.

A portion of IC-1's output is diverted through resistor R26 and diode D5, and fed to pin 3 of IC-2. When the a-c drive signal is present, the rectified output of D5 across R27 is increased. This voltage cancels the fixed d-c bias on pin 2 and the motor drives at full speed.

When the error input signal to the amplifier is suddenly reduced to zero, the output signal from IC-1 quickly drops to zero. As the signal decreases, the bias on pin 2 of IC-2 also decreases, thus allowing the bias on pin 3 to take over. This will increase the d-c current in the motor control field. Due to motor inertia, a back voltage is induced in the control field. This back voltage, rectified by D6, is applied to pin 3 of IC-2, as an increased bias. Consequently, a pulse of current is applied to the control field which acts as a motor brake. Capacitor C23 and Resistor R34 form a feedback path around the output stage and control the rate at which the motor balance current stabilizes. Capacitor C26 absorbs large voltage spikes across the motor windings to protect the output transistors.

Overall signal phase shift through the amplifier is 90°. This is the sum of several shifts throughout the amplifier. The largest of these shifts, approximately 60°, occurs as the signal passes through the filter. The overall 90° shift corresponds to the phase shift required for the control winding of the servomotor.

The voltage reference supply is powered from a separate low-voltage winding on the power transformer. The a-c voltage is rectified through D1 and filtered by C30. The resulting d-c voltage is applied to current regulator Q6, through R43. Zener diode Z3, connected across the base and emitter junctions of Q6, maintains a constant emitter current. Further regulation is provided by zener diode Z2 connected across output of Q6. Final output adjustment of the reference voltage is controlled by potentiometer R40. This factory adjustment seldom requires field adjustment.



△ NOTE: FOR AUXILIARY GAIN, A CABLE (DASHED LINES) IS USED INSTEAD OF A JUMPER.

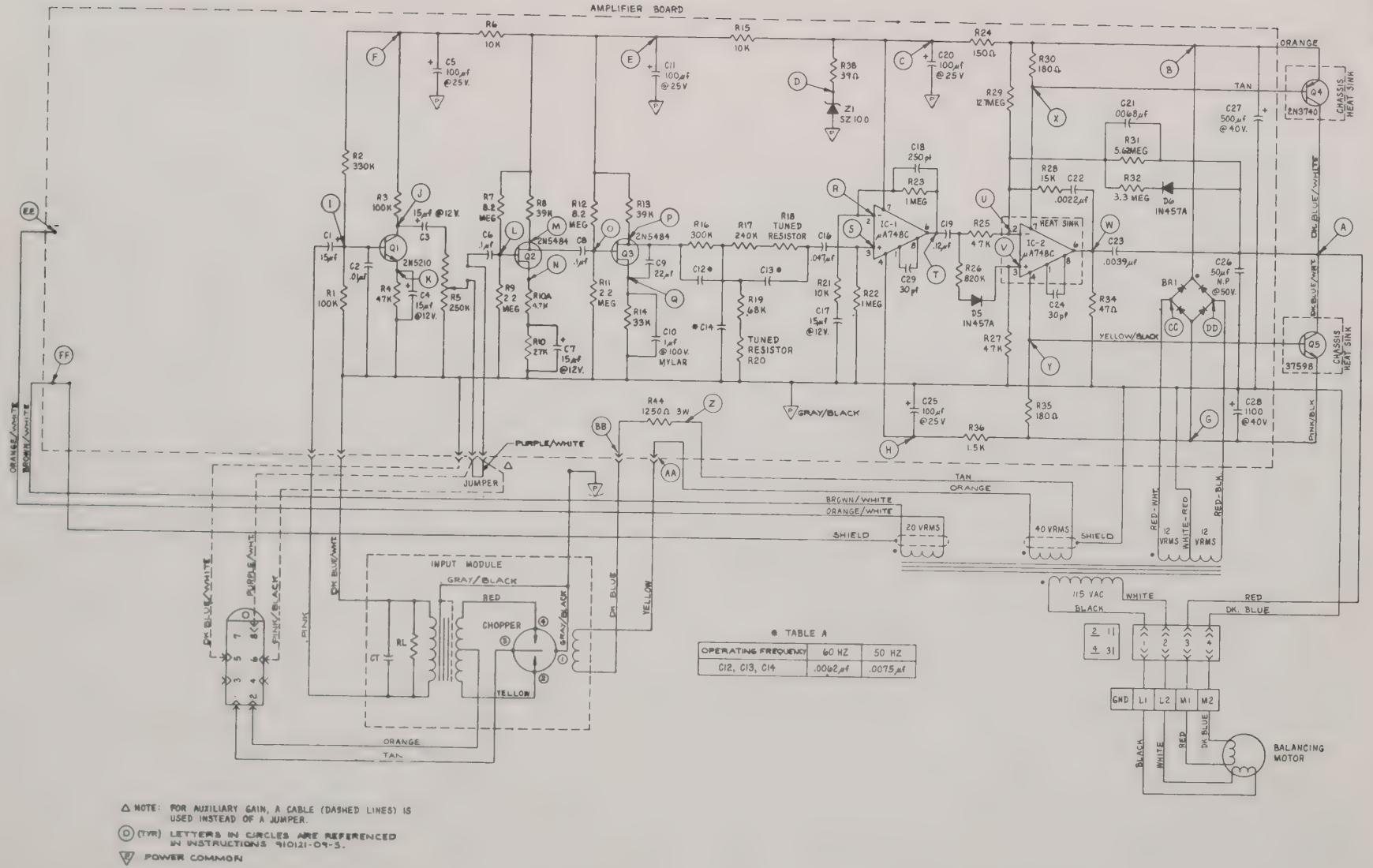
Ⓓ (TYR) LETTERS IN CIRCLES ARE REFERENCED IN INSTRUCTIONS 910121-09-3

▽ POWER COMMON

* TABLE A

OPERATING FREQUENCY	60 HZ	50 HZ
C12, C13, C14	.0062 μf	.0075 μf

FIGURE 3. SCHEMATIC: BASIC D-C AMPLIFIER



△ NOTE: FOR AUXILIARY GAIN, A CABLE (DASHED LINES) IS USED INSTEAD OF A JUMPER.

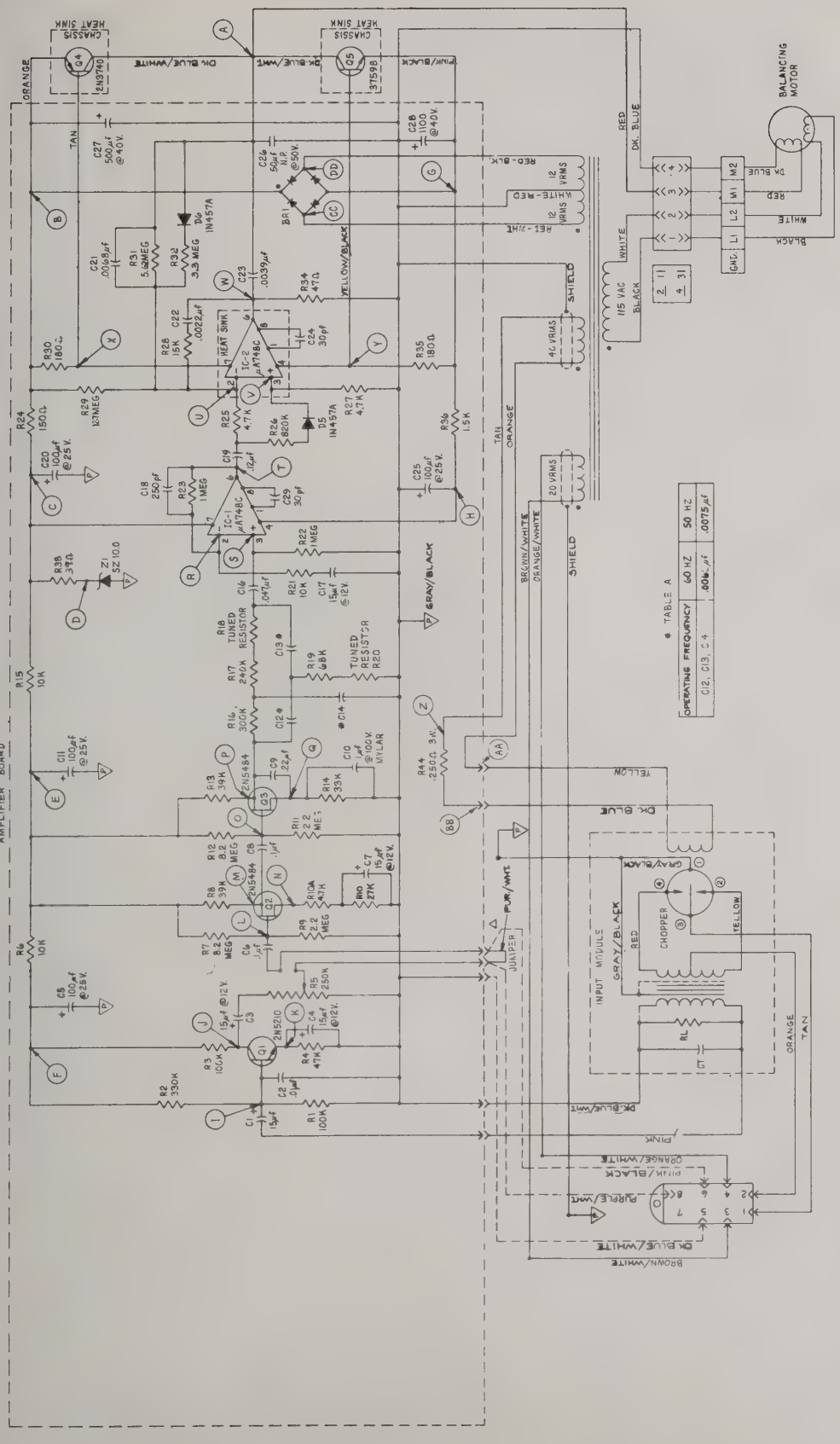
Ⓓ (TYP) LETTERS IN CIRCLES ARE REFERENCED IN INSTRUCTIONS 910121-09-S.

▽ POWER COMMON

* TABLE A

OPERATING FREQUENCY	60 HZ	50 HZ
C12, C13, C14	.0062 μf	.0075 μf

FIGURE 4. SCHEMATIC: D-C AMPLIFIER WITHOUT INTERNAL REFERENCE SOURCE

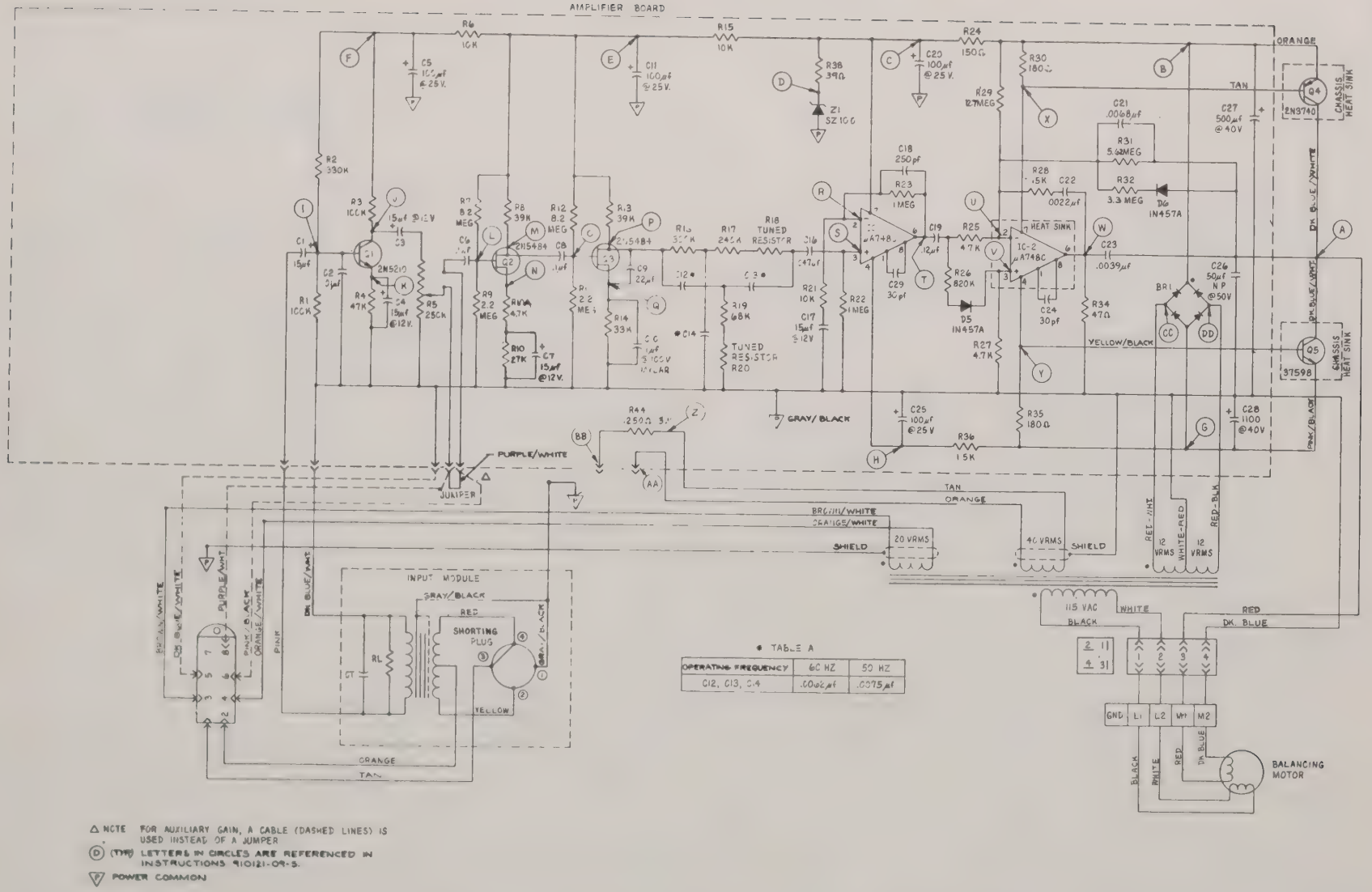


△ NOTE FOR AUXILIARY GAIN, A CABLE (DASHED LINES) IS USED INSTEAD OF A JUMPER

Ⓓ (TYP) LETTERS IN CIRCLES ARE REFERENCED IN INSTRUCTIONS 91021-04-3

▽ POWER COMMON

FIGURE 5. SCHEMATIC: D-C AMPLIFIER WITHOUT INTERNAL REFERENCE SOURCE
(20 VAC WIRED TO INPUT CONNECTOR)



△ NOTE FOR AUXILIARY GAIN, A CABLE (DASHED LINES) IS USED INSTEAD OF A JUMPER

Ⓓ (TYP) LETTERS IN CIRCLES ARE REFERENCED IN INSTRUCTIONS 910121-09-S.

▽ POWER COMMON

FIGURE 6. SCHEMATIC: A-C AMPLIFIER WITHOUT INTERNAL REFERENCE SOURCE
(20 VAC WIRED TO INPUT CONNECTOR)

SERVICE

A. Required Test Equipment

1. **Buffered Electronic A-C D-C Voltmeter:** Accuracy of ±3% with 10 megohm input.
2. **Oscilloscope:** Sensitivity of 2 MV/CM.
3. **D-C Milliammeter:** 0/1000 ma range.
4. **Digital Voltmeter:** Accuracy of ±.01% (Used for calibration of reference voltage).
5. **Input Plug and Cable Adapter:** Bristol Part #591195-01-1.
6. **Power Plug and Cable Adapter:** Bristol Part #591196-01-8.

B. Removal of Amplifier from Instrument

The removal procedure described below is typical for most DYNAMASTER instruments.

1. Turn off a-c line power to DYNAMASTER instrument.
2. Open front door of instrument and slide chassis forward until amplifier is accessible.
3. At this point the protective screen covering the amplifier and bridge assembly is removed.

   WARNING: High voltage may be present in this area even though the a-c power is turned off. Before removing the screen, make sure that any electrical potentials greater than 30 volts are removed from the signal input and guard circuitry. This caution is necessary to prevent electrical shock.

4. Unplug input and power plugs from amplifier chassis.
5. Loosen two holding screws on amplifier chassis.
6. Position amplifier chassis until screw head clears slotted hole on amplifier flange.
7. Lift amplifier slightly and slide partially out of instrument.
8. Remove amplifier from instrument and place on bench for servicing.

C. Setting up Amplifier for Servicing

1. Make sure bench is covered with insulating material.
2. Tape a piece of cardboard over power transistor cases to prevent accidental grounding.
3. Remove protection shroud from amplifier (2 screws).
4. Position amplifier so printed circuit board is accessible.
5. Plug in power plug and cable adapter to power socket.
6. Connect dummy load for Servo motor (15 ohms, 10 watt resistor) across blue and red leads of power cable. Tie shielded wire to ground.
7. Connect milliammeter in series with dummy load (blue wire of power cable).
8. Plug in input plug and cable adapter to input socket.

9. Separate all leads on ends of input and power adapters so that none are shorting.
10. Apply a-c line power to power cable adapter. Connect hi side of line to black wire, and grounded conductor to white wire. Use caution to prevent shock.
11. Proceed with d-c voltage checks of next paragraph.

D. D-C Voltage Readings

1. Connect tan and orange leads of input cable adapter together and tie to amplifier chassis. Connect chassis to ground.
2. Turn Gain Adj. to maximum clockwise position.
3. Measure d-c voltages at test points using a buffered electronic voltmeter (BEVM). Voltage readings and test points are indicated in figure 7.

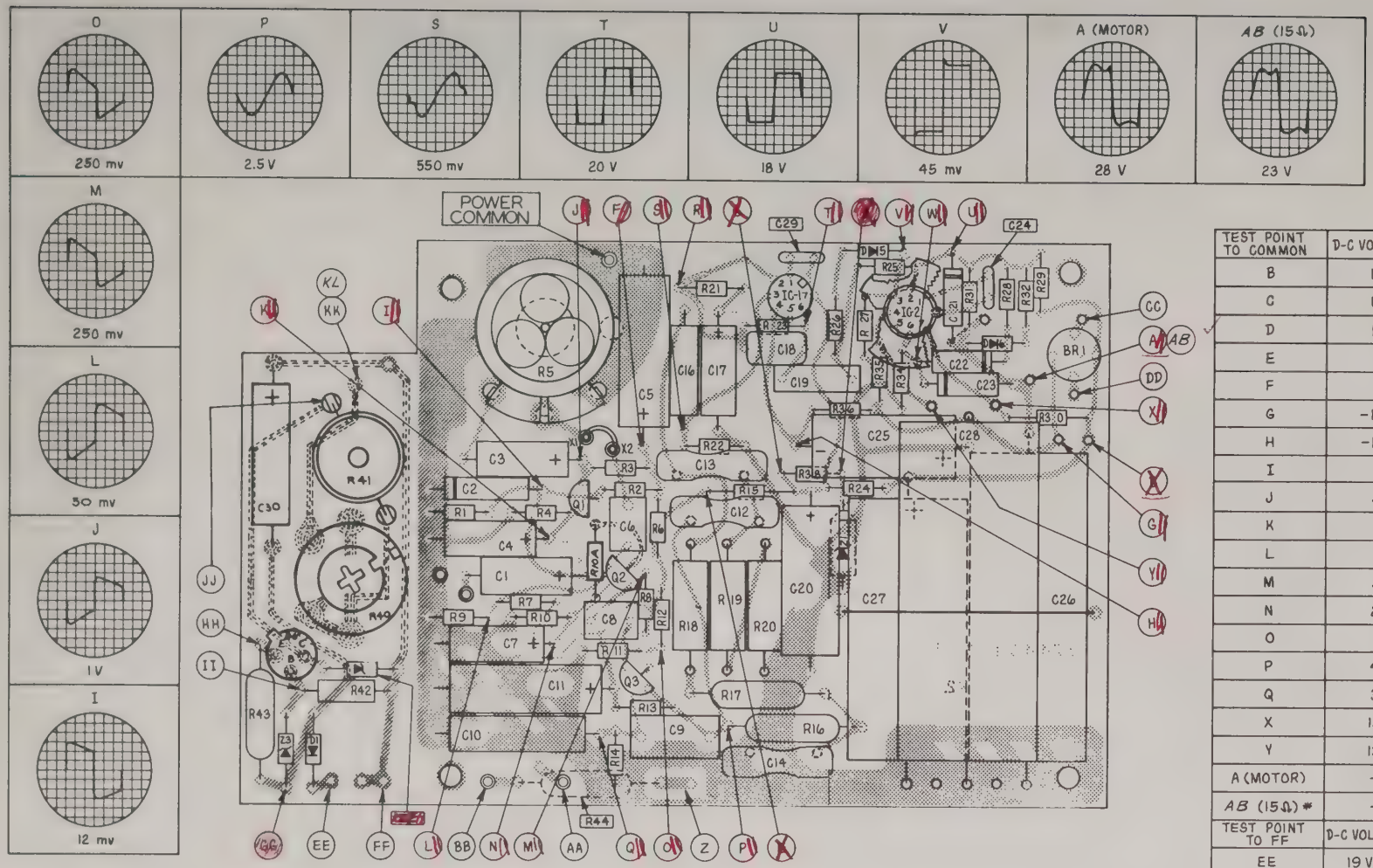
E. Wave Form Analysis (D-C Input Amplifier)

1. Connect an adjustable d-c voltage standard (100 millivolt) across tan and orange leads of input cable adapter through a 10K ohm metal film resistor. Tie shield to tan lead.
2. If amplifier is equipped with auxiliary gain feature, connect jumper across X1 and X2. See figure 7.
3. If amplifier has a 100K-ohm input impedance, apply 10 millivolts from voltage standard. If input impedance is 1000 ohms, apply 3 millivolts.
4. Connect an oscilloscope probe to test point I and shielded lead to supply common. Note shape and amplitude of wave form.
5. Transfer oscilloscope probe to test point J. If wave forms do not comply with those given for test points I and J in figure 7, adjust output of voltage standard until they agree.
6. Place oscilloscope probe on test point L. If wave form does not correspond, set gain adjustment until amplitude is correct.
7. Once initial wave forms are correct, proceed with remainder of checks at indicated test points.

NOTE: When a 15-ohm dummy load is used in place of the motor, the output is indicated by waveform AB. If the motor is the load, use wave form A for the output.

F. Wave Form Analysis (A-C Input Amplifier)

1. Connect an adjustable a-c voltage source (0-2 volts) across tan and orange leads through a 10K metal film resistor. Tie shield to tan lead.
2. If amplifier is equipped with auxiliary gain feature, connect jumper across X1 and X2.
3. Connect oscilloscope probe to test point I and shielded lead to supply common. Note shape and amplitude of wave form. See figure 4.
4. Adjust output of voltage standard until wave form is as shown in figure 4.
5. Transfer oscilloscope probe to test point J. If wave form on oscilloscope does not comply with that shown for test point J, readjust output of voltage standard.
6. Place oscilloscope probe on test point S. If wave form does not correspond with figure 4, set gain adjustment until amplitude is correct.



TEST POINT TO COMMON	D-C VOLTS ±15%
B	13.8
C	10.3
D	9.4
E	8.0
F	7.5
G	-14.0
H	-12.1
I	1.8
J	5.4
K	1.3
L	1.5
M	5.3
N	2.8
O	1.4
P	4.8
Q	3.2
X	13.2
Y	13.7
A (MOTOR)	-5
AB (15Ω) **	-9
TEST POINT TO FF	D-C VOLTS ±10%
EE	19 V (A-C)
GG	-21.7
HH	-16.7
II	-16.0
JJ	-9.0 ± 5%
*** KL	-8.0 ± .03%
** KK	-1.019 ±.03%

NOTES:
1. ALL WAVEFORMS INDICATED IN PEAK-TO-PEAK VALUES.
2. MEASUREMENTS MADE WITH RESPECT TO POWER COMMON UNLESS SPECIFIED DIFFERENTLY IN TEXT.

* = VALUE FOR DUMMY LOAD
** = VALUE FOR 8 VOLT REFERENCE SUPPLY
*** = VALUE FOR 1 VOLT REFERENCE SUPPLY

FIGURE 7. AMPLIFIER TEST POINTS

7. Once initial wave forms are correct, proceed with remainder of checks at indicated test points.

NOTE: When a 15-ohm dummy load is used in place of the motor winding use waveform AB. If the motor itself is the load, use waveform A.

G. Measuring Motor Current

1. Connect milliammeter in series with 15-ohm dummy load resistor. Observe meter polarity.
2. Unplug pink and blue/white wires emanating from input module of amplifier (input module is a plug-in assembly containing the input transformer and chopper).
3. Place a jumper across the two pins to short input circuit.
4. Meter reading should be approximately 450 milliamps with 15-ohm dummy load. If motor is used as load, meter reading will be approximately 550 milliamps.

H. Calibrating 1.019V Reference Source

1. Connect a 339.6 ohm ±.05% resistor across yellow and purple leads of input cable adapter.
2. Connect digital voltmeter across the resistor. Voltage should be 1.019 vdc, ±.00031 volts.
3. If voltage is out of tolerance, adjust potentiometer R40 for the correct reading. If reference voltage cannot be adjusted, check readings indicated in the appropriate schematic. Voltage readings for the reference supply should be made with respect to point FF shown in figure 7.

I. Calibrating 8.000V Reference Source

1. Connect a 2666.7 ohm, ±.05% resistor across yellow and purple leads of the input cable adapter.
2. Connect digital voltmeter across the resistor. Voltage should be 8.000 vdc., ±.0024 vdc.
3. If voltage is out of tolerance, adjust potentiometer R40 for the correct reading. If reference cannot be adjusted, check readings indicated in the appropriate schematic. Voltage readings for the reference supply should be made with respect to point FF shown in figure 7.

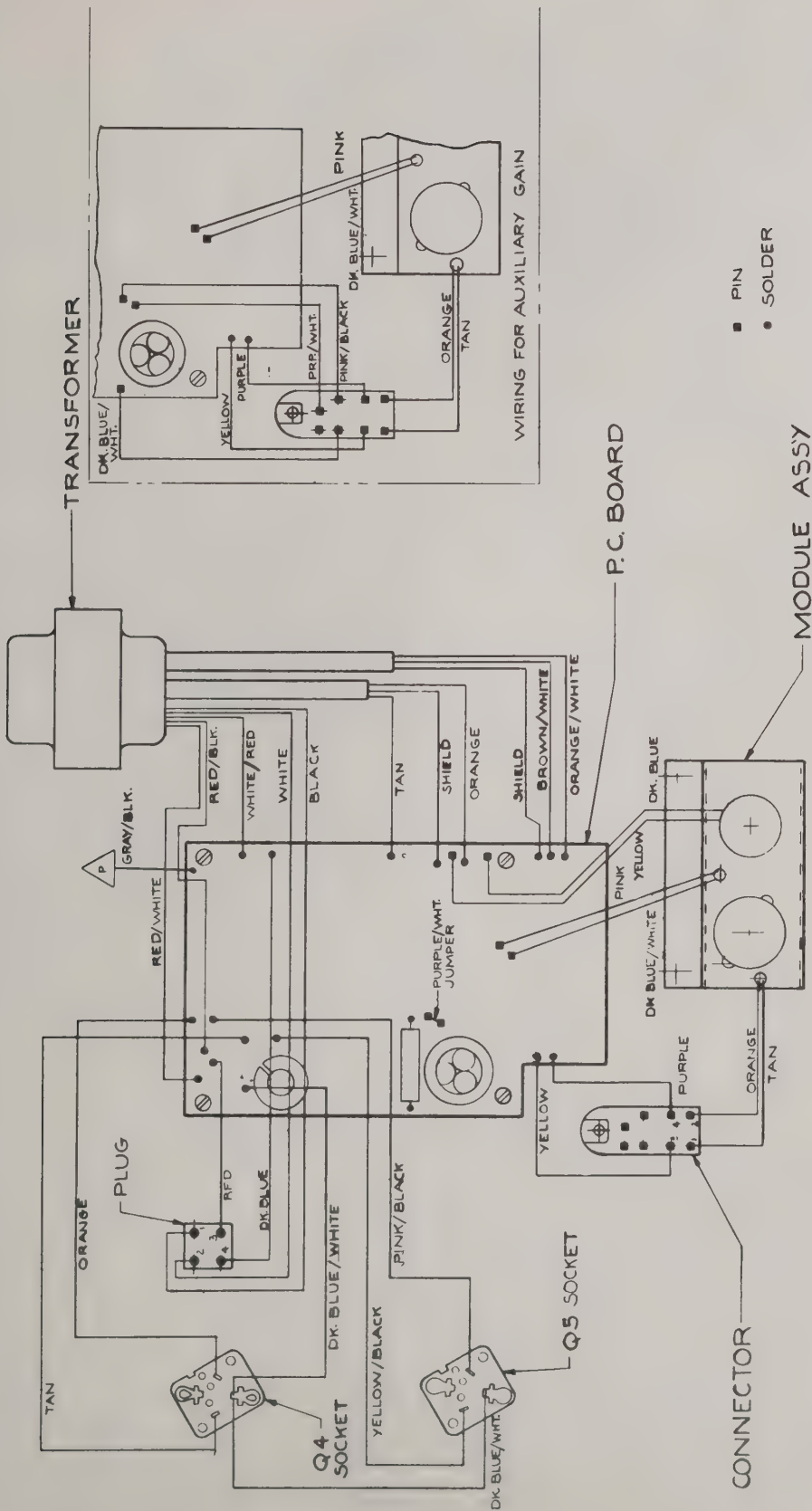


FIGURE 8. PICTORIAL WIRING OF BASIC D-C AMPLIFIER

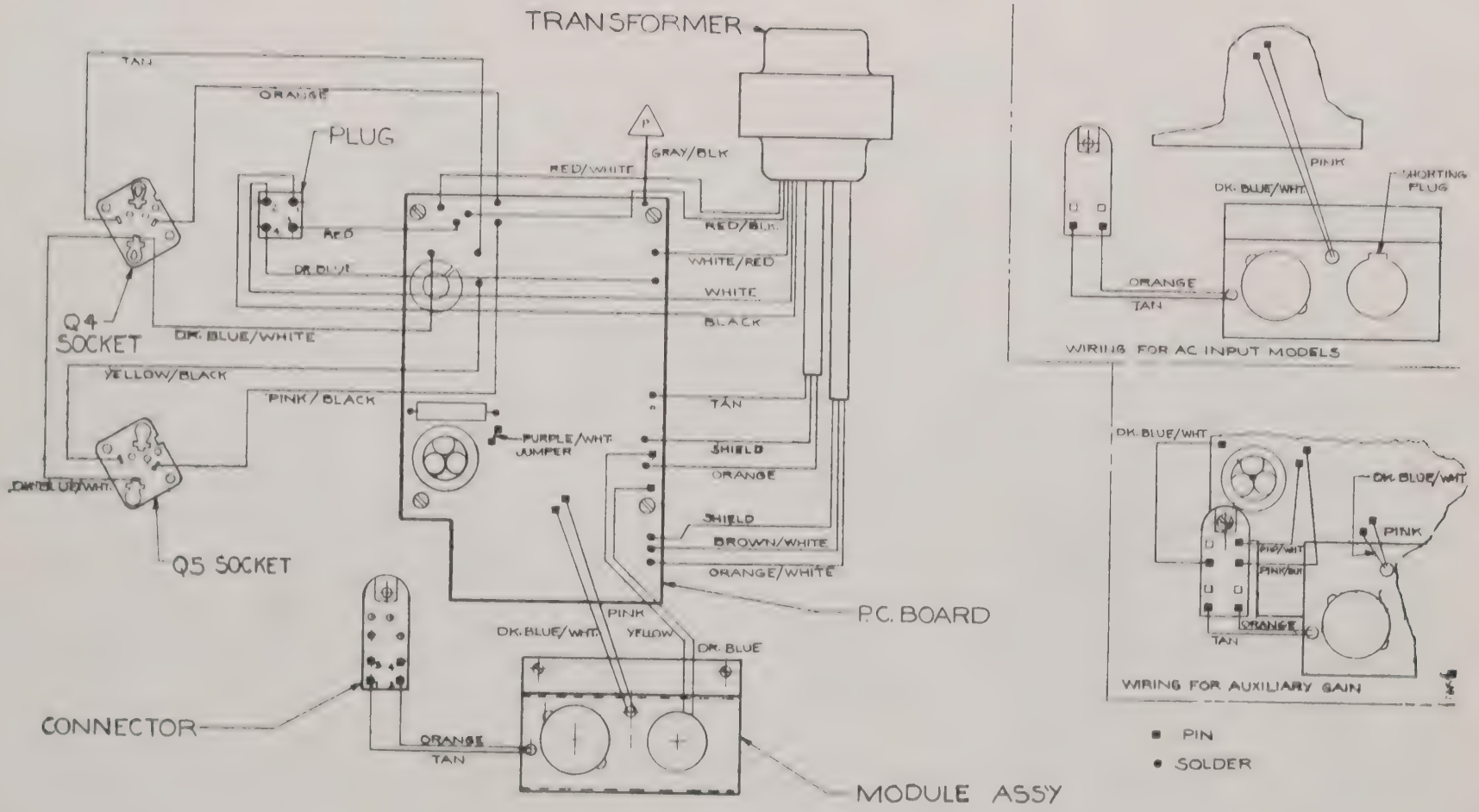


FIGURE 9. PICTORIAL WIRING OF D-C OR A-C AMPLIFIER WITHOUT INTERNAL REF. SOURCE

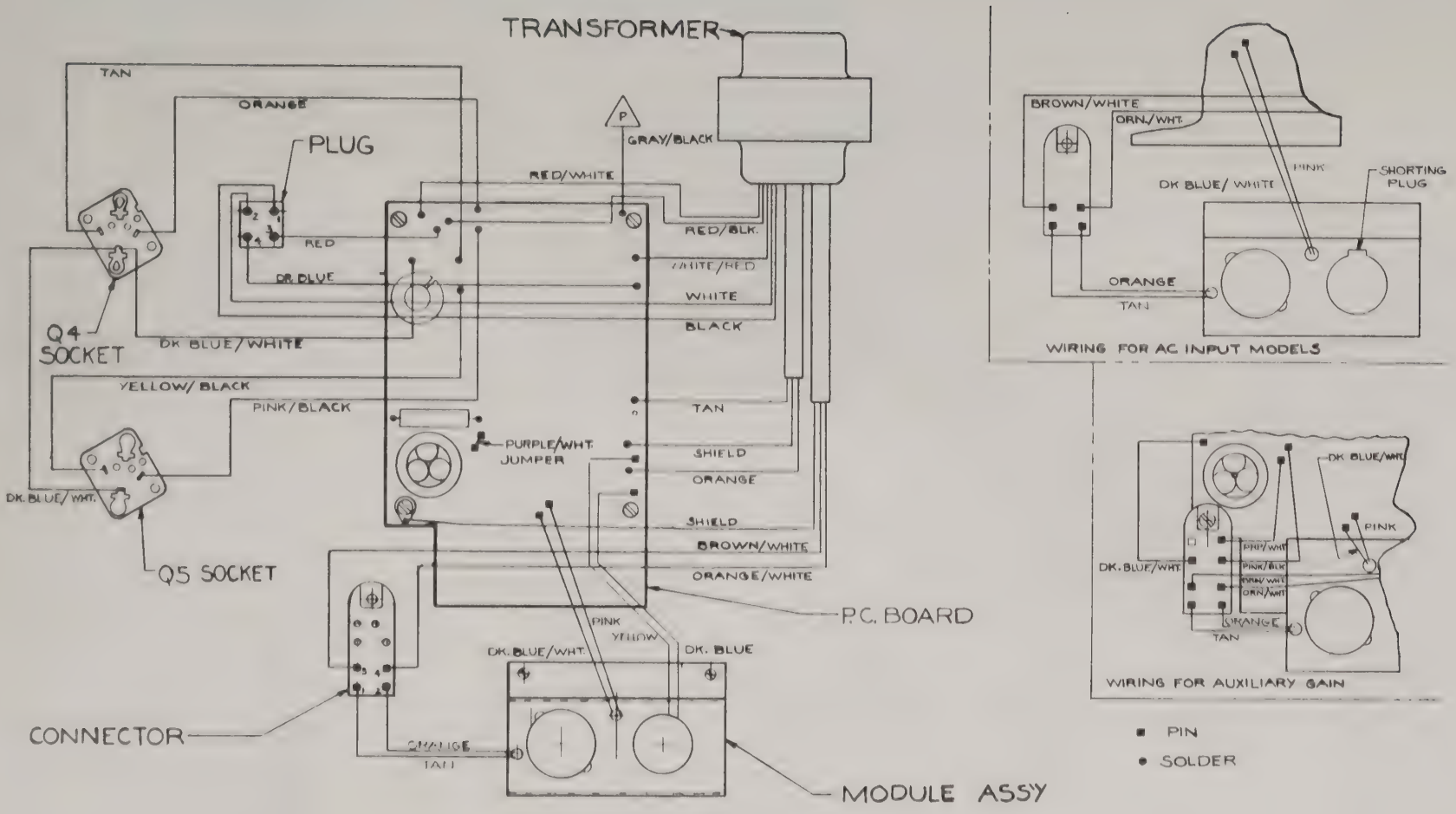


FIGURE 10. PICTORIAL WIRING OF D-C OR A-C AMPLIFIER WITHOUT INTERNAL REF. SOURCE

(20 VAC WIRED TO INPUT CONNECTOR)

REPAIRS, SHIPPING & CORRESPONDENCE

If it becomes necessary to return a BRISTOL instrument or device for repairs, it may be shipped directly to the ACCO Bristol Division plant in Waterbury, Connecticut. Attach a tag to the item describing the symptoms or difficulties experienced in use. Be sure that the item is securely packed and that a complete return address is included.

Replacement parts are also ordered from the Waterbury plant. Include instrument model and serial numbers in the order. Specify part numbers where applicable. Do not send parts orders to local sales offices as this will only cause unnecessary delays. General correspondence and inquiries, however, should always be mailed to a local ACCO Bristol Division Sales Office for fastest replies.

ELECTRICAL GROUNDING OF INSTRUMENT ENCLOSURES

Enclosures of electrical instruments must be grounded in accordance with the rules and regulations of Occupational Safety and Health Standard, 1919.314 (g) (3), dated May 29, 1971. Reference source: National Electrical Code, NFPA 70-1971, Section 250-123.

The grounding requirement is also applicable to mechanical instruments that include electrical devices.

NOTE

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the Bristol Division of ACCO, Waterbury, Connecticut 06720. As a measurement, control or protection device or system, customer should note that a failure of this instrument or system for whatever reason, may leave the monitored process unprotected. It is suggested that the customer review the need for further redundant or other alternate means of protection.

ACCO || Bristol Division

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BRISTOL®
instruments/systems

parts list

3/79 (B) P12578—1

DYNAMASTER®

SERIES "S" AMPLIFIERS

BASE PT. NOS. 374591, 374592, 374593,

374594, 374595 & 374596

PART NUMBER	TYPE INPUT SIGNAL	INPUT IMPEDANCE OHMS	REFERENCE VOLTAGE	AUXILIARY GAIN FEATURE	A-C POWER
374591-10-5	DC	100K	1.0190 VDC	WITHOUT	120V @ 60 HZ
374591-11-3	DC	100K	1.0190 VDC	WITH	120V @ 60 HZ
374591-20-2	DC	1K	1.0190 VDC	WITHOUT	120V @ 60 HZ
374591-21-0	DC	1K	1.0190 VDC	WITH	120V @ 60 HZ
374592-10-1	DC	100K	1.0190 VDC	WITHOUT	120V @ 50 HZ
374592-11-0	DC	100K	1.0190 VDC	WITH	120V @ 50 HZ
374592-20-9	DC	1K	1.0190 VDC	WITHOUT	120V @ 50 HZ
374592-21-7	DC	1K	1.0190 VDC	WITH	120V @ 50 HZ
374593-10-8	DC	100K	Ext. DC	WITHOUT	120V @ 60 HZ
374593-20-5	DC	1K	Ext. DC	WITHOUT	120V @ 60 HZ
374594-10-4	DC	100K	Ext. DC	WITHOUT	120V @ 50 HZ
374594-20-1	DC	1K	Ext. DC	WITHOUT	120V @ 50 HZ
374595-10-0	DC	100K	8.000 VDC	WITHOUT	120V @ 60 HZ
374595-20-8	DC	1K	Ext. DC	WITHOUT	120V @ 60 HZ
374595-40-2	AC	1K	Ext. AC	WITHOUT	120V @ 60 HZ
374596-10-7	DC	100K	8.000 VDC	WITHOUT	120V @ 50 HZ
374596-20-4	DC	1K	Ext. AC	WITHOUT	120V @ 50 HZ
374596-40-9	AC	1K	Ext. AC	WITHOUT	120V @ 50 HZ

Bristol Division of Acco

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American Chain & Cable Company, Inc.
A Subsidiary of Babcock International Inc.

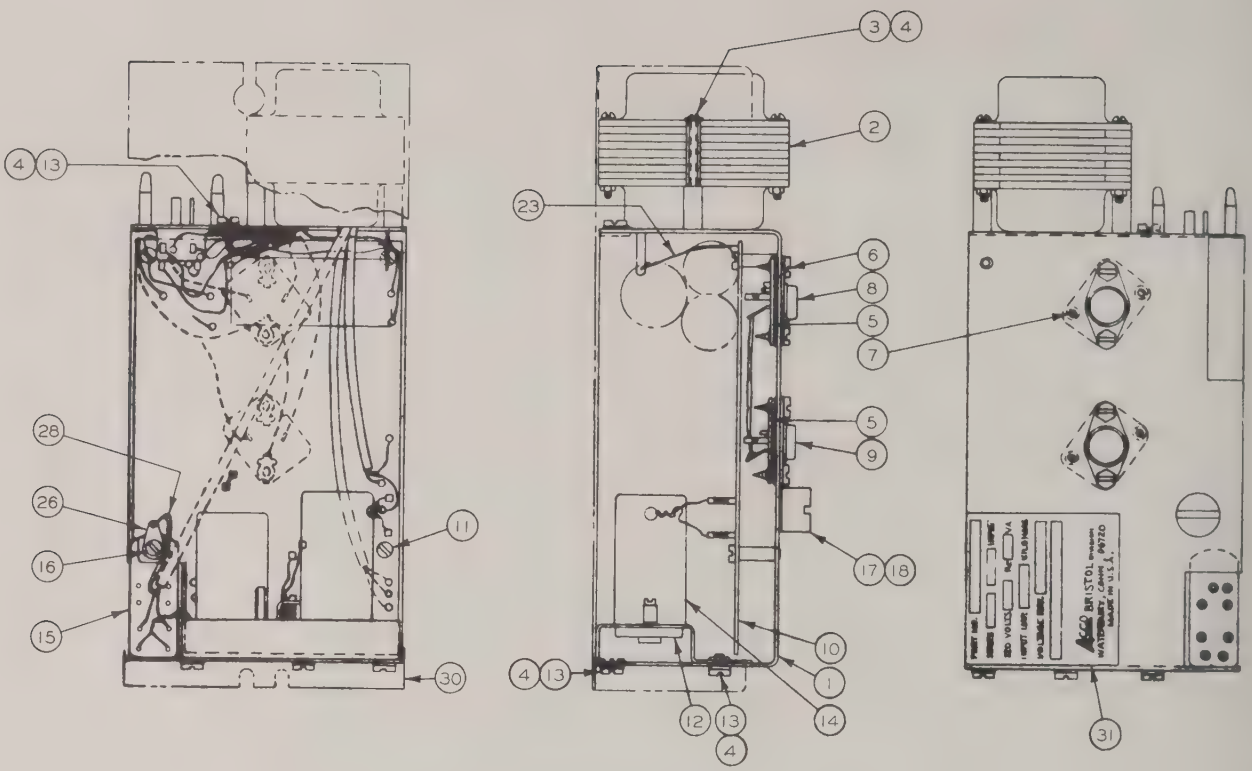

FIG. 1. AMPLIFIER ASSEMBLY (BASIC CHASSIS)

A. Amplifier Assembly (Figure 1)

ITEM	DESCRIPTION	PART NUMBER
1	Amplifier Chassis Ass'y	374445-01-0
2	Transformer	374414-01-7
3	Screw, #6-32 x 1-1/8" Lg.	315839-00-7
4	Lock Washer, #6	279008-00-7
5	Socket ASsembly	374466-01-7
6	Screw, Sheet Metal #6 x 3/8"	315541-00-8
7	Screw, #4 - 48 x 1/8" Fil. Hd.	210626-00-3
8	Transistor 2N3740	370013-02-6
9	Transistor 37598	314743-00-6
10	P.C. Board Assembly	*
11	Screw, #6 - 40 x 3/16" Fil. Hd.	218339-00-3
12	Input Module Assembly:	
	100K Input	374441-01-4
	1K Input	374441-02-2
13	Scr. #6 - 32 x 3/16" Bind. Hd.	373861-01-0
14	Switch, Syncroverter	341415-05-7
15	Connector	379477-01-7
16	Scr. #6 - 40 x 3/8" Fil. Hd.	218329-00-8
17	Knob	315547-00-6
18	Scr. Set #6 - 40 x 1/8"	282403-00-0
30	Shield	343202-00-0
31	Nameplate	370354-01-0

* Specify amplifier part number when ordering

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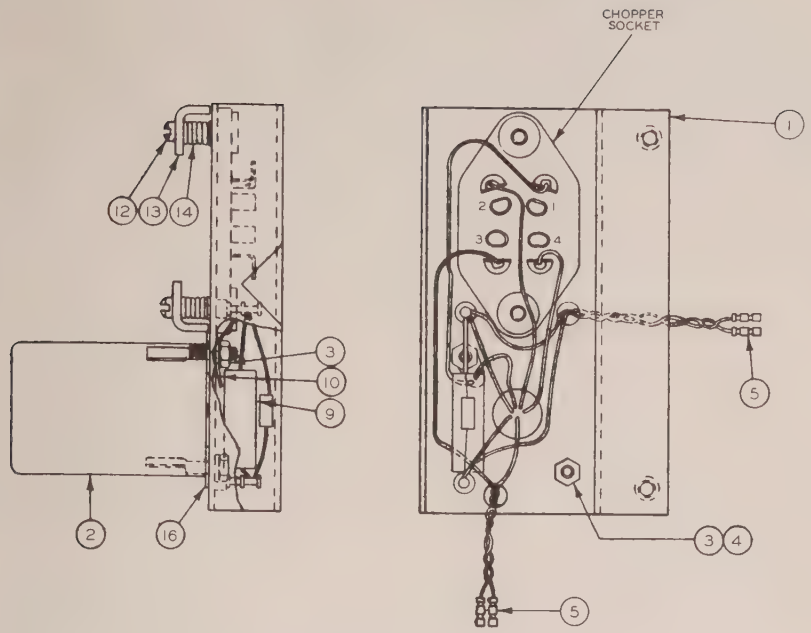

FIG. 2. INPUT MODULE ASSEMBLY

B. Input Module Assembly (Figure 2)

1	Bracket Assembly	374439-01-0
2	Transformer (Input)	334010-00-4
3	Nut #6 - 32	292923-00-7
4	Washer, #6 Shakeproof	243040-00-8
5	Receptacle	314757-00-7
9	Capacitor .068	317321-00-5
10	Solder Lug	312426-00-3
12	Screw #4 - 48 x 1/2 Fil. Hd.	241516-00-5
13	Bracket	304963-00-3
14	Spring	304961-00-0
16	Washer, #6	221252-00-2

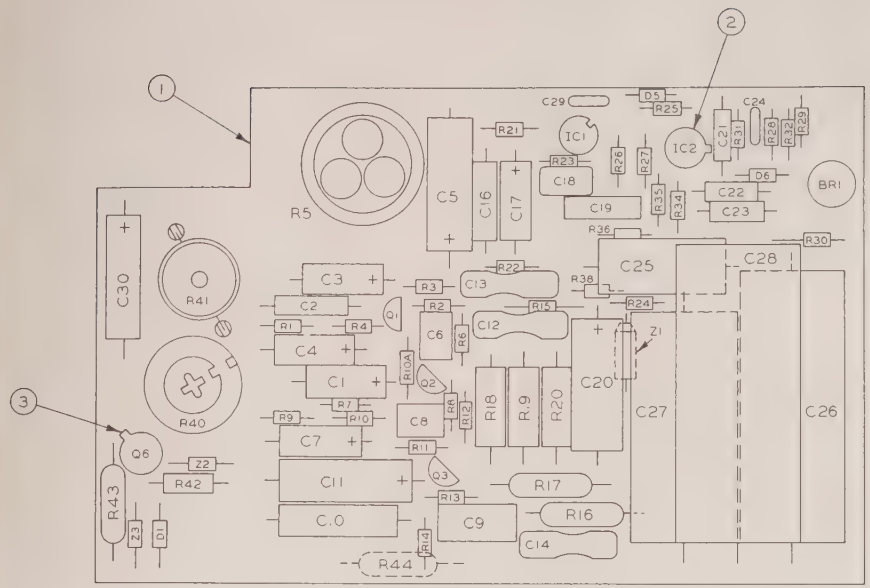

FIG. 3. PRINTED CIRCUIT BOARD ASSEMBLY

C. Printed Circuit Board Assembly (Figure 3)

ITEM	DESCRIPTION	PART NUMBER
1	Printed Circuit Board	374404-01-1
2	Heat Dissipator	379787-01-6
3	Transipad	314417-00-1
	RESISTORS	
R1,R3	100K ±10%, 1/4W Carbon	314731-00-8
R2	330K " "	316198-04-8
R4	47K " "	314421-00-9
R5	Potentiometer, 250K	317201-00-0
R6,R21,R15	10K 1/4W Carbon	314405-00-3
R7,R12	8.2M " "	316198-55-2
R8,R13	39K " "	314728-00-7
R9,R11	2.2M " "	316198-53-6
R10	27K " "	314409-00-9
R14	33K " "	314727-00-0
R16	300K ±2%, 1/2W W.W.	297685-00-7
R17	240K ±2%, 1/2W W.W.	297684-00-0
R19	68K ±10%, 1W. Carbon	289085-00-4
R22, R23	1M 1/4W Carbon	314411-00-3
R24	150 " "	316198-27-7
R25,R27,R10A	4.7 " "	314403-00-0
R26	820K " "	316198-06-4
R28	15K " "	314407-00-6
R29	12.7M ±2% Metal Film	383108-04-7
R30,R35	180 1/4W Carbon	316198-12-9
R31	5.62M ±2% Metal Film	383108-03-9
R32	3.3M 1/4W Carbon	316198-25-0
R34	47 " "	314603-00-0
R38	39 " "	316198-44-7
R44	1250 ±10%, 3W, W.W.	312829-00-0

ITEM	DESCRIPTION	PART NUMBER
	CAPACITORS	
C1,C3,C4,C7,C17	15uf @ 12V Electrolytic	371044-05-7
C5,C11,C20,C25	100uf @ 25V Electrolytic	371044-04-9
C2	.01uf @ 100V ±10% Mylar	309601-00-2
C6,C8	.1uf @ 50V ±10% Poly.	374469-01-6
C9	.22uf @ 50V ±10% Poly.	374469-03-2
C10	1uf @ 100V Mylar	315539-00-3
C12,C13,C14	.0062uf @ 300V ±5%	370008-09-0
C16	.047uf @ 100V ±10% Mylar	311603-00-9
C18	250pf Mica	370008-03-0
C19	.12uf @ 50V ±10% Poly.	374469-02-4
C21	.0068uf @100V ±10% Mylar	370031-03-2
C22	.0022uf @100V ±10% Mylar	312206-00-3
C23	.0039uf @100V ±10% Mylar	370031-12-1
C24,C29	30pf Mica	370008-08-1
C26	50uf @ 50V N.P. Electro	316181-05-6
C27	500 mf @ 40 vdc	371263-03-4
	TRANSISTORS	
Q1	2N5210	370010-02-7
Q2,Q3	2N5484 FET	370010-03-5
	INTEGRATED CIRCUITS	
IC-1, IC-2	ML5001BT	379775-01-8
	DIODES	
D5,D6	IN457A	315461-00-4
Z1	Zener Voltage 10.0	370023-03-0
BR1	Bridge Rectifier	373151-01-2
	TUNING RESISTORS	
R18*	±10%, 1 Watt, Carbon	
R20*	±10%, 1 Watt, Carbon	
	OPTIONAL COMPONENTS FOR INTERNAL 1.019V REF. SUPPLY	
C30	Capacitor, 50uf @50V	307053-00-8
R43	Resist.464 ±1%, 1/2 W.M.F.	313692-00-9
R42	Resistor 1.8K ±10%, 1/2W.	312665-00-8
R40	Potentiometer, 50	313691-00-2
D1	Diode IN4002	312645-00-7
Z3	Diode, Zener IN752A	313694-00-1
Z2	Diode, Zener IN936	312804-00-8
Q6	Transistor, TN59	315465-00-0
R41*	Resistor Cal. Spool	

*Value selected per Factory Calibration

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NOTE: The tables contained in this booklet are based on NBS Research Paper 2415 and NBS Circular 508 as adopted by the Scientific Apparatus Makers Association and the Instrument Society of America.

Bristol Division of Acco

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American Chain & Cable Company, Inc.
A Subsidiary of Babcock International Inc.

J °F

IRON-CONSTANTAN THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = −1.22 mv)

EMF IN ABSOLUTE MILLIVOLTS																				
°F.	0	−5	−10	−15	−20	−25	−30	−35	−40	−45	−50	−55	−60	−65	−70	−75	−80	−85	−90	−95	°F.
−300	−8.74	−8 81	−8.88	−8.95	−9.01																−300
−200	−6.98	−7.08	−7.18	−7.28	−7.38	−7.47	−7.57	−7.66	−7.75	−7.84	−7.93	−8.02	−8.11	−8.19	−8.28	−8.36	−8.44	−8.52	−8.60	−8.67	−200
−100	−4.71	−4.83	−4.95	−5.07	−5.19	−5.31	−5.43	−5.55	−5.66	−5.78	−5.90	−6.01	−6.12	−6.23	−6.34	−6.45	−6.56	−6.66	−6.77	−6.87	−100
0	−2.11	−2.24	−2.38	−2.51	−2.65	−2.78	−2.92	−3.05	−3.18	−3.31	−3.44	−3.57	−3.70	−3.83	−3.96	−4.08	−4.21	−4.34	−4.46	−4.58	0
°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	−2.11	−1.97	−1.83	−1.70	−1.56	−1.42	−1.28	−1.14	−1.00	−0.86	−0.72	−0.57	−0.43	−0.29	−0.15	0.00	0.14	0.29	0.43	0.58	0
100	0.72	0.87	1.01	1.16	1.30	1.45	1.60	1.75	1.89	2.04	2.19	2.34	2.49	2.64	2.79	2.94	3.09	3.24	3.39	3.54	100
200	3.69	3.84	3.99	4.14	4.29	4.44	4.59	4.74	4.89	5.05	5.20	5.35	5.50	5.65	5.81	5.96	6.11	6.26	6.42	6.57	200
300	6.72	6.88	7.03	7.18	7.34	7.49	7.65	7.80	7.95	8.11	8.26	8.42	8.57	8.73	8.88	9.03	9.19	9.34	9.50	9.65	300
400	9.81	9.96	10.12	10.27	10.43	10.58	10.74	10.89	11.04	11.20	11.35	11.51	11.66	11.82	11.97	12.12	12.28	12.43	12.59	12.74	400
500	12.90	13.05	13.20	13.36	13.51	13.66	13.82	13.97	14.12	14.28	14.43	14.58	14.74	14.89	15.04	15.20	15.35	15.50	15.66	15.81	500
600	15.96	16.12	16.27	16.42	16.58	16.73	16.89	17.04	17.19	17.35	17.50	17.65	17.81	17.96	18.12	18.27	18.42	18.58	18.73	18.88	600
700	19.04	19.19	19.34	19.50	19.65	19.80	19.96	20.11	20.26	20.42	20.57	20.72	20.88	21.03	21.18	21.33	21.49	21.64	21.79	21.95	700
800	22.10	22.25	22.41	22.56	22.71	22.87	23.02	23.17	23.33	23.48	23.63	23.79	23.94	24.10	24.25	24.40	24.56	24.71	24.87	25.02	800
900	25.18	25.33	25.48	25.64	25.80	25.95	26.11	26.26	26.42	26.58	26.73	26.89	27.04	27.20	27.36	27.52	27.67	27.83	27.99	28.15	900
1000	28.30	28.46	28.62	28.78	28.94	29.10	29.26	29.42	29.58	29.74	29.90	30.06	30.22	30.38	30.54	30.70	30.86	31.02	31.18	31.34	1000
1100	31.50	31.67	31.83	31.99	32.15	32.32	32.48	32.64	32.81	32.97	33.14	33.30	33.46	33.63	33.79	33.96	34.13	34.29	34.46	34.62	1100
1200	34.79	34.96	35.13	35.30	35.47	35.64	35.80	35.98	36.14	36.32	36.49	36.66	36.83	37.00	37.17	37.35	37.52	37.69	37.86	38.04	1200
1300	38.21	38.39	38.56	38.74	38.91	39.09	39.26	39.44	39.61	39.79	39.97	40.14	40,32	40.50	40.68	40.85	41.03	41.21	41.39	41.56	1300
1400	41.74	41.92	42.10	42.28	42.46	42.63	42.81	42.99	43.17	43.35	43.53	43.71	43.88	44.06	44.24	44.42	44.60	44.78	44.96	45.13	1400
1500	45.31	45.49	45.67	45.85	46.02	46.20	46.38	46.56	46.73	46.91	47.09	47.26	47.44	47.61	47.79	47.96	48.14	48.31	48.48	48.66	1500
1600	48.83																				1600

J °C

IRON-CONSTANTAN THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0° C = −1.28 mv)

EMF IN ABSOLUTE MILLIVOLTS																				
°C.	0	−5	−10	−15	−20	−25	−30	−35	−40	−45	−50	−55	−60	−65	−70	−75	−80	−85	−90	−95	°C.
−100	−5.91	−6.11	−6.31	−6.51	−6.70	−6.89	−7.08	−7.26	−7.44	−7.61	−7.78	−7.94	−8.10	−8.25	−8.40	−8.55	−8.68	−8.82	−8.94	−9.06	−100
0	−1.28	−1.53	−1.78	−2.03	−2.28	−2.52	−2.76	−3.00	−3.24	−3.48	−3.71	−3.94	−4.17	−4.40	−4.62	−4 84	−5.06	−5.28	−5.49	−5.70	0
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	−1.28	−1.03	−0.78	−0.52	−0.26	0.00	0.26	0.52	0.78	1.04	1.30	1.57	1.83	2.10	2.37	2.64	2.91	3.18	3.45	3.72	0
100	3.99	4.26	4.53	4.80	5.08	5.35	5.62	5.90	6.17	6.45	6.72	7.00	7.28	7.56	7.83	8.11	8.39	8.67	8.94	9.22	100
200	9.50	9.78	10.06	10.34	10.61	10.89	11.17	11.45	11.73	12.00	12.28	12.56	12.84	13.11	13.39	13.66	13.94	14.22	14.49	14.77	200
300	15.05	15.32	15.60	15.87	16.15	16.43	16.70	16.98	17.26	17.53	17.81	18.09	18.36	18.64	18.92	19.19	19.47	19.74	20.02	20.29	300
400	20.57	20 85	21.12	21.40	21.67	21.95	22.22	22.50	22.78	23.05	23.33	23.60	23.88	24.16	24.44	24.71	24.99	25.27	25.55	25.83	400
500	26.11	26.39	26.67	26.95	27.24	27.52	27.80	28.09	28.37	28.66	28.94	29.23	29.52	29.80	30.09	30.38	30.67	30.96	31.25	31.54	500
600	31.83	32.13	32.42	32.71	33.01	33.30	33.60	33.90	34.20	34.50	34.80	35.10	35.41	35.71	36.02	36.32	36.63	36.94	37.25	37.56	600
700	37.87	38.19	38.50	38.82	39.13	39.45	39.77	40.08	40.40	40.72	41.04	41.36	41.68	42.00	42.32	42.64	42.97	43.29	43.61	43.93	700
800	44.25	44.57	44.90	45.22	45.54	45.86	46.18	46.50	46.81	47.13	47.45	47.76	48.08	48.39	48.70						800

T (24B) °F

COPPER-CONSTANTAN THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = –0.944 mv)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	–5	–10	–15	–20	–25	–30	–35	–40	–45	–50	–55	–60	–65	–70	–75	–80	–85	–90	–95	°F.
–300	–6.228	–6.276	–6.323																		–300
–200	–5.055	–5.123	–5.190	–5.256	–5.321	–5.385	–5.448	–5.510	–5.571	–5.632	–5.691	–5.749	–5.807	–5.863	–5.918	–5.973	–6.025	–6.078	–6.129	–6.179	–200
–100	–3.503	–3.589	–3.674	–3.758	–3.841	–3.924	–4.006	–4.087	–4.167	–4.245	–4.324	–4.401	–4.477	–4.553	–4.628	–4.701	–4.773	–4.845	–4.916	–4.986	–100
0	–1.614	–1.715	–1.816	–1.917	–2.016	–2.115	–2.214	–2.311	–2.407	–2.503	–2.598	–2.692	–2.786	–2.878	–2.970	–3.061	–3.151	–3.240	–3.329	–3.416	– 0
°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	–1.614	–1.511	–1.407	–1.303	–1.198	–1.093	–0.986	–0.880	–0.773	–0.664	–0.555	–0.445	–0.335	–0.224	–0.112	0.000	0.113	0.227	0.342	0.457	0
100	0.573	0.689	0.807	0.925	1.043	1.163	1.282	1.402	1.523	1.645	1.767	1.891	2.014	2.138	2.263	2.388	2.514	2.640	2.768	2.895	100
200	3.023	3.152	3.281	3.411	3.542	3.673	3.805	3.936	4.070	4.203	4.336	4.471	4.606	4.741	4.877	5.013	5.150	5.288	5.426	5.564	200
300	5.703	5.842	5.982	6.122	6.264	6.405	6.547	6.689	6.832	6.976	7.120	7.263	7.408	7.553	7.698	7.844	7.991	8.138	8.285	8.432	300
400	8.581	8.730	8.879	9.029	9.179	9.329	9.479	9.630	9.782	9.934	10.086	10.239	10.392	10.546	10.699	10.853	11.009	11.164	11.319	11.474	400
500	11.631	11.788	11.944	12.102	12.259	12.418	12.576	12.734	12.894	13.053	13.213	13.373	13.533	13.693	13.855	14.017	14.178	14.340	14.503	14.666	500
600	14.829	14.993	15.157	15.320	15.485	15.649	15.814	15.980	16.145	16.311	16.477	16.644	16.810	16.977	17.145	17.313	17.481	17.649	17.817	17.986	600
700	18.156	18.325	18.495	18.664	18.835	19.005	19.176	19.347	19.519	19.690	19.861										700

T (24B) °C

COPPER-CONSTANTAN THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0° C = –0.990 mv)

EMF IN ABSOLUTE MILLIVOLTS

°C.	0	–5	–10	–15	–20	–25	–30	–35	–40	–45	–50	–55	–60	–65	–70	–75	–80	–85	–90	–95	°C.
–100	–4.339	–4.478	–4.614	–4.747	–4.877	–5.004	–5.128	–5.249	–5.367	–5.482	–5.593	–5.702	–5.807	–5.909	–6.008	–6.103	–6.195	–6.284	–6.369		–100
0	–0.990	–1.181	–1.370	–1.557	–1.741	–1.923	–2.102	–2.279	–2.453	–2.625	–2.794	–2.961	–3.125	–3.286	–3.445	–3.601	–3.754	–3.904	–4.052	–4.197	0
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	–0.990	–0.797	–0.601	–0.403	–0.203	0.000	0.204	0.411	0.620	0.831	1.045	1.260	1.477	1.697	1.918	2.142	2.367	2.594	2.823	3.054	0
100	3.287	3.522	3.759	3.997	4.237	4.479	4.722	4.967	5.214	5.463	5.713	5.964	6.218	6.472	6.729	6.988	7.246	7.507	7.769	8.033	100
200	8.298	8.565	8.833	9.103	9.373	9.645	9.919	10.193	10.469	10.745	11.025	11.304	11.585	11.867	12.150	12.435	12.720	13.007	13.295	13.583	200
300	13.874	14.165	14.457	14.750	15.045	15.340	15.636	15.934	16.232	16.531	16.831	17.133	17.435	17.737	18.042	18.347	18.652	18.959	19.267	19.575	300
400	19.884																				400

(25H) °F

CHROMEL-ALUMEL THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = −0.95 mv)

(25H)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	−5	−10	−15	−20	−25	−30	−35	−40	−45	−50	−55	−60	−65	−70	−75	−80	−85	−90	−95	°F.
−300	−6.46	−6.50	−6.55																		−300
−200	−5.24	−5.31	−5.39	−5.46	−5.53	−5.59	−5.66	−5.72	−5.79	−5.85	−5.91	−5.97	−6.03	−6.09	−6.15	−6.20	−6.25	−6.31	−6.36	−6.41	−200
−100	−3.60	−3.69	−3.78	−3.87	−3.96	−4.05	−4.14	−4.22	−4.31	−4.39	−4.47	−4.55	−4.64	−4.71	−4.79	−4.87	−4.95	−5.02	−5.10	−5.17	−100
0	−1.63	−1.74	−1.84	−1.94	−2.05	−2.15	−2.25	−2.35	−2.45	−2.55	−2.65	−2.75	−2.85	−2.94	−3.04	−3.13	−3.23	−3.32	−3.42	−3.51	0
°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	−1.63	−1.53	−1.42	−1.32	−1.21	−1.10	−0.99	−0.88	−0.77	−0.66	−0.55	−0.44	−0.33	−0.22	−0.11	0.00	0.11	0.23	0.34	0.45	0
100	0.57	0.68	0.79	0.91	1.02	1.14	1.25	1.37	1.48	1.60	1.71	1.83	1.94	2.06	2.17	2.29	2.41	2.52	2.64	2.75	100
200	2.87	2.99	3.10	3.22	3.33	3.45	3.56	3.68	3.79	3.91	4.02	4.13	4.25	4.36	4.47	4.58	4.70	4.81	4.92	5.03	200
300	5.14	5.25	5.36	5.47	5.58	5.70	5.81	5.92	6.03	6.14	6.25	6.36	6.47	6.58	6.69	6.80	6.92	7.03	7.14	7.25	300
400	7.36	7.47	7.59	7.70	7.81	7.92	8.03	8.14	8.26	8.37	8.48	8.59	8.71	8.82	8.93	9.05	9.16	9.27	9.39	9.50	400
500	9.62	9.73	9.84	9.96	10.07	10.18	10.30	10.41	10.53	10.64	10.76	10.87	10.99	11.10	11.22	11.33	11.45	11.56	11.68	11.79	500
600	11.91	12.02	12.14	12.25	12.37	12.49	12.60	12.72	12.83	12.95	13.07	13.18	13.30	13.41	13.53	13.65	13.76	13.88	14.00	14.11	600
700	14.23	14.35	14.46	14.58	14.70	14.81	14.93	15.05	15.17	15.28	15.40	15.52	15.64	15.75	15.87	15.99	16.11	16.22	16.34	16.46	700
800	16.58	16.69	16.81	16.93	17.05	17.16	17.28	17.40	17.52	17.63	17.75	17.87	17.99	18.11	18.23	18.34	18.46	18.58	18.70	18.82	800
900	18.94	19.06	19.18	19.29	19.41	19.53	19.65	19.77	19.89	20.00	20.12	20.24	20.36	20.48	20.59	20.71	20.83	20.95	21.07	21.19	900
1000	21.31	21.42	21.54	21.66	21.78	21.90	22.02	22.13	22.25	22.37	22.49	22.61	22.73	22.85	22.96	23.08	23.20	23.32	23.44	23.56	1000
1100	23.68	23.79	23.91	24.03	24.15	24.27	24.39	24.51	24.62	24.74	24.86	24.98	25.10	25.21	25.33	25.45	25.57	25.68	25.80	25.92	1100
1200	26.03	26.15	26.27	26.39	26.50	26.62	26.74	26.85	26.97	27.09	27.20	27.32	27.44	27.55	27.67	27.79	27.91	28.02	28.14	28.26	1200
1300	28.37	28.49	28.61	28.72	28.84	28.96	29.07	29.19	29.30	29.42	29.54	29.65	29.77	29.88	30.00	30.12	30.23	30.35	30.47	30.58	1300
1400	30.70	30.81	30.93	31.04	31.16	31.27	31.39	31.50	31.62	31.73	31.85	31.96	32.07	32.19	32.30	32.42	32.53	32.64	32.76	32.87	1400
1500	32.98	33.10	33.21	33.33	33.44	33.55	33.67	33.78	33.89	34.01	34.12	34.23	34.34	34.46	34.57	34.68	34.80	34.91	35.02	35.13	1500
1600	35.24	35.36	35.47	35.58	35.69	35.81	35.92	36.03	36.14	36.25	36.36	36.48	36.59	36.70	36.81	36.92	37.03	37.14	37.25	37.37	1600
1700	37.48	37.59	37.70	37.81	37.92	38.03	38.14	38.25	38.36	38.47	38.58	38.69	38.80	38.91	39.01	39.12	39.23	39.34	39.45	39.56	1700
1800	39.67	39.78	39.89	40.00	40.10	40.21	40.32	40.43	40.54	40.65	40.75	40.86	40.97	41.08	41.19	41.29	41.40	41.51	41.62	41.72	1800
1900	41.83	41.94	42.04	42.15	42.26	42.36	42.47	42.58	42.68	42.79	42.90	43.00	43.11	43.22	43.32	43.43	43.54	43.64	43.75	43.85	1900
2000	43.96	44.06	44.17	44.27	44.38	44.48	44.59	44.69	44.80	44.90	45.01	45.11	45.22	45.32	45.43	45.53	45.63	45.74	45.84	45.95	2000
2100	46.05	46.15	46.26	46.36	46.46	46.57	46.67	46.77	46.87	46.98	47.08	47.18	47.28	47.39	47.49	47.59	47.69	47.79	47.90	48.00	2100
2200	48.10	48.20	48.30	48.40	48.50	48.60	48.70	48.81	48.91	49.01	49.11	49.21	49.31	49.41	49.51	49.61	49.70	49.80	49.90	50.00	2200
2300	50.10	50.20	50.30	50.40	50.50	50.59	50.69	50.79	50.89	50.99	51.08	51.18	51.28	51.38	51.47	51.57	51.67	51.77	51.86	51.96	2300
2400	52.06	52.15	52.25	52.35	52.44	52 54	52.64	52.73	52.83	52.92	53.02	53.11	53.21	53.30	53.40	53.49	53.59	53.68	53.78	53.87	2400
2500	53.97	54.07	54.16	54.26	54.35	54.45	54.54	54.64	54.73	54.83	54.92	55.02	55.11	55.21	55.30	55.40	55.49	55.59	55.68	55.78	2500
2600	55.87	55.97	56.06	56.16	56.25	56.35	56.44	56.54	56.63	56.73	56.82										2600

K (25H) °C

CHROMEL-ALUMEL THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0° C = −1.00 mv)

EMF IN ABSOLUTE MILLIVOLTS

°C.	0	−5	−10	−15	−20	−25	−30	−35	−40	−45	−50	−55	−60	−65	−70	−75	−80	−85	−90	−95	°C.
−200	−6.75																				−200
−100	−4.49	−4.64	−4.78	−4.92	−5.06	−5.19	−5.32	−5.45	−5.58	−5.70	−5.81	−5.92	−6.03	−6.14	−6.24	−6.34	−6.43	−6.52	−6.60	−6.68	−100
0	−1.00	−1.19	−1.39	−1.58	−1.77	−1.95	−2.14	−2.32	−2.50	−2.68	−2.86	−3.03	−3.20	−3.37	−3.54	−3.71	−3.87	−4.03	−4.19	−4.34	0
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	−1.00	−0.80	−0.60	−0.40	−0.20	0.00	0.20	0.40	0.61	0.81	1.02	1.23	1.43	1.64	1.85	2.05	2.26	2.47	2.68	2.89	0
100	3.10	3.31	3.51	3.72	3.92	4.13	4.33	4.53	4.73	4.93	5.13	5.33	5.53	5.73	5.93	6.13	6.33	6.53	6.73	6.93	100
200	7.13	7.33	7.54	7.74	7.94	8.14	8.34	8.54	8.75	8.95	9.16	9.36	9.57	9.77	9.98	10.18	10.39	10.59	10.80	11.01	200
300	11.21	11.42	11.63	11.83	12.04	12.25	12.46	12.67	12.88	13.09	13.29	13.50	13.71	13.92	14.13	14.34	14.55	14.76	14.98	15.19	300
400	15.40	15.61	15.82	16.03	16.24	16.46	16.67	16.88	17.09	17.30	17.51	17.73	17.94	18.15	18.36	18.58	18.79	19.01	19.22	19.43	400
500	19.65	19.86	20.07	20.28	20.50	20.71	20.92	21.14	21.35	21.56	21.78	21.99	22.20	22.42	22.63	22.84	23.06	23.27	23.49	23.70	500
600	23.91	24.12	24.34	24.55	24.76	24.98	25.19	25.40	25.61	25.82	26.03	26.24	26.45	26.66	26.87	27.08	27.29	27.50	27.72	27.93	600
700	28.14	28.35	28.56	28.77	28.97	29.18	29.39	29.60	29.81	30.02	30.23	30.44	30.65	30.85	31.06	31.27	31.48	31.68	31.89	32.09	700
800	32.30	32.50	32.71	32.91	33.12	33.32	33.53	33.73	33.93	34.14	34.34	34.54	34.75	34.95	35.15	35.35	35.55	35.76	35.96	36.16	800
900	36.36	36.56	36.76	36.96	37.16	37.36	37.56	37.76	37.95	38.15	38.35	38.55	38.75	38.94	39.14	39.34	39.53	39.73	39.92	40.12	900
1000	40.31	40.51	40.70	40.90	41.09	41.29	41.48	41.67	41.87	42.06	42.25	42.44	42.63	42.83	43.02	43.21	43.40	43.59	43.78	43.97	1000
1100	44.16	44.35	44.54	44.73	44.92	45.11	45.29	45.48	45.67	45.85	46.04	46.23	46.41	46.60	46.78	46.97	47.15	47.34	47.52	47.70	1100
1200	47.89	48.07	48.25	48.43	48.62	48.80	48.98	49.16	49.34	49.52	49.69	49.87	50.05	50.23	50.41	50.58	50.76	50.94	51.11	51.29	1200
1300	51.46	51.64	51.81	51.99	52.16	52.34	52.51	52.68	52.85	53.03	53.20	53.37	53.54	53.71	53.88						1300

S °F

PLATINUM-PLATINUM, 10% RHODIUM THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = –0.136 mv)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	–0.236	–0.220	–0.205	–0.189	–0.173	–0.158	–0.142	–0.127	–0.112	–0.096	–0.080	–0.065	–0.049	–0.032	–0.016	0.000	0.017	0.034	0.051	0.068	0
100	0.085	0.102	0.120	0.138	0.155	0.173	0.191	0.210	0.228	0.247	0.265	0.284	0.303	0.322	0.341	0.360	0.380	0.399	0.419	0.439	100
200	0.459	0.479	0.499	0.519	0.540	0.560	0.581	0.602	0.622	0.643	0.664	0.686	0.707	0.728	0.750	0.771	0.793	0.815	0.837	0.858	200
300	0.881	0.903	0.925	0.947	0.970	0.992	1.015	1.037	1.060	1.083	1.106	1.128	1.151	1.175	1.198	1.221	1.244	1.268	1.291	1.314	300
400	1.338	1.362	1.385	1.409	1.433	1.457	1.480	1.504	1.528	1.552	1.576	1.600	1.625	1.649	1.673	1.697	1.722	1.746	1.771	1.795	400
500	1.820	1.845	1.869	1.894	1.919	1.944	1.969	1.994	2.019	2.044	2.069	2.094	2.119	2.145	2.170	2.195	2.221	2.246	2.271	2.297	500
600	2.322	2.348	2.374	2.399	2.425	2.451	2.477	2.502	2.528	2.554	2.580	2.606	2.632	2.658	2.684	2.710	2.736	2.762	2.788	2.815	600
700	2.841	2.867	2.893	2.920	2.946	2.972	2.999	3.025	3.052	3.078	3.104	3.131	3.157	3.184	3.211	3.237	3.264	3.290	3.317	3.344	700
800	3.370	3.397	3.424	3.451	3.478	3.504	3.531	3.558	3.585	3.612	3.639	3.666	3.693	3.720	3.747	3.774	3.801	3.828	3.855	3.883	800
900	3.910	3.937	3.964	3.992	4.019	4.046	4.074	4.101	4.128	4.156	4.183	4.211	4.238	4.266	4.294	4.321	4.349	4.376	4.404	4.432	900
1000	4.460	4.487	4.515	4.543	4.571	4.599	4.627	4.654	4.682	4.710	4.738	4.766	4.794	4.823	4.851	4.879	4.907	4.935	4.963	4.992	1000
1100	5.020	5.048	5.076	5.105	5.133	5.162	5.190	5.218	5.247	5.275	5.304	5.333	5.361	5.390	5.419	5.447	5.476	5.504	5.533	5.562	1100
1200	5.590	5.619	5.648	5.677	5.706	5.735	5.763	5.792	5.821	5.850	5.879	5.908	5.937	5.966	5.995	6.025	6.054	6.083	6.112	6.141	1200
1300	6.171	6.200	6.229	6.258	6.288	6.317	6.347	6.376	6.406	6.435	6.465	6.494	6.524	6.553	6.583	6.613	6.642	6.672	6.702	6.731	1300
1400	6.761	6.791	6.821	6.851	6.881	6.910	6.940	6.970	7.000	7.030	7.060	7.090	7.121	7.151	7.181	7.211	7.241	7.271	7.302	7.332	1400
1500	7.362	7.393	7.423	7.453	7.484	7.514	7.545	7.575	7.606	7.636	7.667	7.698	7.728	7.759	7.789	7.820	7.851	7.882	7.912	7.943	1500
1600	7.974	8.005	8.036	8.067	8.098	8.129	8.160	8.191	8.222	8.253	8.284	8.315	8.346	8.377	8.409	8.440	8.471	8.502	8.534	8.565	1600
1700	8.596	8.628	8.659	8.691	8.722	8.754	8.785	8.817	8.848	8.880	8.912	8.943	8.975	9.007	9.038	9.070	9.102	9.134	9.166	9.197	1700
1800	9.229	9.261	9.293	9.325	9.357	9.389	9.421	9.453	9.485	9.518	9.550	9.582	9.614	9.646	9.679	9.711	9.743	9.776	9.808	9.840	1800
1900	9.873	9.905	9.938	9.970	10.003	10.035	10.068	10.101	10.133	10.166	10.198	10.231	10.264	10.297	10.329	10.362	10.395	10.428	10.461	10.493	1900
2000	10.526	10.559	10.592	10.625	10.658	10.691	10.724	10.757	10.790	10.823	10.856	10.889	10.922	10.955	10.988	11.021	11.054	11.088	11.121	11.154	2000
2100	11.187	11.220	11.253	11.287	11.320	11.353	11.386	11.420	11.453	11.486	11.519	11.553	11.586	11.619	11.653	11.686	11.719	11.752	11.786	11.819	2100
2200	11.853	11.886	11.919	11.953	11.986	12.019	12.053	12.086	12.120	12.153	12.186	12.220	12.253	12.287	12.320	12.354	12.387	12.420	12.454	12.487	2200
2300	12.521	12.554	12.588	12.621	12.654	12.688	12.721	12.755	12.788	12.821	12.855	12.888	12.922	12.955	12.988	13.022	13.055	13.088	13.122	13.155	2300
2400	13.189	13.222	13.255	13.289	13.322	13.355	13.389	13.422	13.455	13.489	13.522	13.555	13.589	13.622	13.655	13.689	13.722	13.755	13.788	13.822	2400
2500	13.855	13.888	13.922	13.955	13.988	14.021	14.055	14.088	14.121	14.154	14.188	14.221	14.254	14.287	14.321	14.354	14.387	14.420	14.453	14.487	2500
2600	14.520	14.553	14.586	14.619	14.653	14.686	14.719	14.752	14.785	14.818	14.852	14.885	14.918	14.951	14.984	15.017	15.050	15.083	15.117	15.150	2600
2700	15.183	15.216	15.249	15.282	15.315	15,348	15.381	15.414	15.447	15.480	15.513	15.546	15.579	15.612	15.645	15.678	15.711	15.744	15.777	15.810	2700
2800	15.843	15.876	15.909	15.942	15.975	16.008	16.041	16.074	16.107	16.139	16.172	16.205	16.238	16.271	16,304	16.337	16.370	16.402	16.435	16.468	2800
2900	16.501	16.534	16.566	16.599	16.632	16.665	16.698	16.730	16.763	16.796	16.829	16.861	16.894	16.927	16.959	16.992	17.025	17.058	17.090	17.123	2900
3000	17.156	17.188	17.221	17.253	17.286	17.319	17.351	17.384	17.416	17.449	17.482	17.514	17.547	17.579	17.612	17.644	17.677	17.709	17.742	17.774	3000
3100	17.807	17.839	17.872	17.904	17.937	17.969	18.001	18.034	18.066	18.099	18.131	18.163	18.196	18.228	18.260	18.293	18.325	18.357	18.390	18.422	3100
3200	18.454	18.486	18.519	18.551																	3200

PLATINUM-PLATINUM, 10% RHODIUM THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C(EMF at 0°C = –0.143 mv)

EMF IN ABSOLUTE MILLIVOLTS																				
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	–0.143	–0.115	–0.087	–0.059	–0.030	0.000	0.030	0.061	0.092	0.123	0.156	0.188	0.221	0.254	0.288	0.323	0.357	0.392	0.428	0.464	0
100	0.500	0.537	0.574	0.611	0.649	0.687	0.726	0.764	0.803	0.843	0.882	0.922	0.963	1.003	1.044	1.085	1.126	1.168	1.209	1.251	100
200	1.293	1.336	1.378	1.421	1.464	1.507	1.550	1.593	1.637	1.681	1.725	1.769	1.813	1.857	1.902	1.947	1.992	2.037	2.082	2.127	200
300	2.173	2.219	2.264	2.310	2.356	2.403	2.449	2.495	2.542	2.588	2.635	2.682	2.729	2.776	2.823	2.871	2.918	2.965	3.013	3.060	300
400	3.108	3.156	3.204	3.251	3.299	3.347	3.396	3.444	3.492	3.540	3.589	3.637	3.686	3.735	3.783	3.832	3.881	3.930	3.979	4.028	400
500	4.078	4.127	4.176	4.226	4.276	4.325	4.375	4.425	4.475	4.525	4.575	4.625	4.675	4.726	4.776	4.827	4.877	4.928	4.979	5.030	500
600	5.081	5.132	5.183	5.234	5.286	5.337	5.389	5.440	5.492	5.543	5.595	5.647	5.699	5.751	5.803	5.855	5.907	5.959	6.012	6.064	600
700	6.117	6.169	6.222	6.275	6.328	6.381	6.434	6.487	6.540	6.594	6.647	6.701	6.754	6.808	6.862	6.915	6.969	7.023	7.077	7.132	700
800	7.186	7.240	7.295	7.349	7.404	7.459	7.513	7.568	7.623	7.678	7.733	7.789	7.844	7.899	7.955	8.010	8.066	8.122	8.177	8.233	800
900	8.289	8.345	8.402	8.458	8.514	8.571	8.627	8.684	8.740	8.797	8.854	8.911	8.968	9.025	9.082	9.139	9.197	9.254	9.312	9.369	900
1000	9.427	9.485	9.543	9.601	9.659	9.717	9.775	9.833	9.892	9.950	10.009	10.067	10.126	10.185	10.244	10.303	10.362	10.421	10.480	10.539	1000
1100	10.598	10.658	10.717	10.776	10.836	10.895	10.955	11.014	11.074	11.134	11.193	11.253	11.313	11.373	11.432	11.492	11.552	11.612	11.672	11.732	1100
1200	11.792	11.852	11.912	11.972	12.032	12.093	12.153	12.213	12.273	12.333	12.393	12.454	12.514	12.574	12.634	12.694	12.754	12.814	12.875	12.935	1200
1300	12.995	13.055	13.115	13.175	13.235	13.295	13.355	13.415	13.475	13.535	13.595	13.655	13.715	13.775	13.835	13.895	13.955	14.014	14.074	14.134	1300
1400	14.194	14.254	14.314	14.373	14.433	14.493	14.553	14.612	14.672	14.732	14.792	14.851	14.911	14.970	15.030	15.090	15.149	15.209	15.268	15.328	1400
1500	15.387	15.447	15.506	15.566	15.625	15.684	15.744	15.803	15.863	15.922	15.981	16.040	16.100	16.159	16.218	16.277	16.336	16.395	16.454	16.514	1500
1600	16.573	16.632	16.691	16.750	16.809	16.867	16.926	16.985	17.044	17.103	17.162	17.220	17.279	17.338	17.396	17.455	17.514	17.572	17.631	17.689	1600
1700	17.748	17.806	17.865	17.923	17.981	18.040	18.098	18.156	18.215	18.273	18.331	18.389	18.447	18.505							1700

R °F

PLATINUM-PLATINUM, 13% RHODIUM THERMOCOUPLES

Degrees Fahrenheit (Int. 1948) Cold End at 75° F (EMF at 32° F = –0.135 mv)

EMF IN ABSOLUTE MILLIVOLTS

°F.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°F.
0	–0.235	–0.220	–0.204	–0.188	–0.173	–0.157	–0.141	–0.126	–0.111	–0.096	–0.080	–0.064	–0.049	–0.032	–0.016	0.000	0.017	0.034	0.051	0.068	0
100	0.085	0.102	0.120	0.137	0.156	0.173	0.192	0.210	0.228	0.246	0.265	0.284	0.303	0.322	0.341	0.361	0.381	0.401	0.421	0.441	100
200	0.461	0.481	0.502	0.522	0.543	0.565	0.586	0.607	0.628	0.650	0.672	0.693	0.715	0.737	0.759	0.782	0.804	0.827	0.849	0.872	200
300	0.895	0.917	0.940	0.963	0.986	1.009	1.032	1.056	1.079	1.103	1.126	1.150	1.174	1.198	1.222	1.246	1.271	1.295	1.320	1.345	300
400	1.369	1.394	1.418	1.443	1.468	1.493	1.518	1.543	1.568	1.594	1.619	1.644	1.670	1.696	1.721	1.747	1.773	1.799	1.825	1.851	400
500	1.877	1.903	1.930	1.956	1.982	2.009	2.035	2.062	2.088	2.115	2.142	2.168	2.195	2.222	2.249	2.277	2.303	2.331	2.358	2.385	500
600	2.412	2.440	2.467	2.495	2.522	2.550	2.577	2.605	2.633	2.661	2.688	2.716	2.744	2.772	2.800	2.828	2.856	2.884	2.912	2.940	600
700	2.968	2.997	3.025	3.053	3.082	3.110	3.138	3.167	3.195	3.224	3.252	3.281	3.310	3.338	3.367	3.396	3.425	3.454	3.483	3.512	700
800	3.542	3.571	3.600	3.629	3.659	3.688	3.717	3.747	3.776	3.806	3.835	3.864	3.894	3.923	3.952	3.981	4.011	4.040	4.070	4.100	800
900	4.129	4.159	4.189	4.219	4.249	4.278	4.308	4.338	4.368	4.398	4.428	4.458	4.489	4.519	4.550	4.580	4.611	4.641	4.672	4.702	900
1000	4.733	4.764	4.795	4.825	4.856	4.887	4.918	4.949	4.980	5.011	5.041	5.073	5.103	5.135	5.166	5.197	5.228	5.259	5.291	5.322	1000
1100	5.353	5.384	5.416	5.447	5.479	5.510	5.542	5.574	5.606	5.638	5.670	5.702	5.734	5.766	5.798	5.829	5.861	5.893	5.925	5.957	1100
1200	5.990	6.021	6.053	6.085	6.117	6.150	6.182	6.214	6.246	6.279	6.311	6.344	6.376	6.409	6.442	6.474	6.507	6.539	6.572	6.605	1200
1300	6.638	6.670	6.703	6.736	6.769	6.802	6.835	6.868	6.902	6.934	6.968	7.001	7.034	7.067	7.100	7.134	7.167	7.201	7.234	7.268	1300
1400	7.301	7.335	7.368	7.402	7.436	7.470	7.504	7.537	7.571	7.605	7.639	7.673	7.707	7.742	7.776	7.810	7.844	7.878	7.912	7.946	1400
1500	7.981	8.015	8.049	8.083	8.118	8.152	8.187	8.221	8.256	8.291	8.325	8.360	8.395	8.430	8.464	8.499	8.534	8.569	8.604	8.639	1500
1600	8.674	8.709	8.744	8.779	8.814	8.849	8.884	8.919	8.955	8.990	9.026	9.061	9.097	9.132	9.168	9.203	9.239	9.274	9.310	9.346	1600
1700	9.381	9.417	9.452	9.488	9.524	9.559	9.595	9.631	9.667	9.703	9.739	9.775	9.811	9.847	9.884	9.921	9.957	9.994	10.029	10.066	1700
1800	10.102	10.139	10.175	10.212	10.248	10.285	10.321	10.358	10.394	10.431	10.468	10.504	10.541	10.577	10.614	10.651	10.688	10.726	10.763	10.801	1800
1900	10.838	10.876	10.913	10.950	10.987	11.025	11.062	11.100	11.138	11.175	11.213	11.250	11.289	11.326	11.364	11.402	11.440	11.478	11.516	11.554	1900
2000	11.591	11.630	11.667	11.705	11.743	11.781	11.819	11.857	11.894	11.933	11.970	12.009	12.047	12.085	12.123	12.161	12.200	12.238	12.276	12.315	2000
2100	12.353	12.391	12.429	12.467	12.506	12.544	12.583	12.621	12.660	12.698	12.736	12.774	12.813	12.851	12.890	12.928	12.967	13.005	13.043	13.081	2100
2200	13.120	13.158	13.197	13.236	13.274	13.313	13.351	13.390	13.429	13.467	13.506	13.544	13.583	13.621	13.660	13.698	13.737	13.776	13.814	13.853	2200
2300	13.892	13.930	13.969	14.007	14.046	14.084	14.123	14.161	14.200	14.239	14.277	14.316	14.355	14.393	14.432	14.471	14.509	14.548	14.586	14.625	2300
2400	14.663	14.702	14.740	14.779	14.817	14.856	14.894	14.933	14.972	15.010	15.049	15.087	15.126	15.164	15.203	15.242	15.280	15.319	15.357	15.396	2400
2500	15.433	15.472	15.510	15.549	15.587	15.626	15.665	15.703	15.742	15.780	15.819	15.857	15.896	15.935	15.973	16.012	16.050	16.089	16.128	16.166	2500
2600	16.205	16.243	16.282	16.320	16.359	16.397	16.436	16.475	16.513	16.552	16.590	16.629	16.667	16.707	16.745	16.783	16.822	16.860	16.898	16.937	2600
2700	16.975	17.013	17.051	17.090	17.128	17.166	17.205	17.243	17.281	17.320	17.358	17.397	17.434	17.473	17.511	17.550	17.588	17.626	17.664	17.702	2700
2800	17.740	17.778	17.816	17.854	17.892	17.930	17.968	18 006	18.044	18.083	18.120	18.159	18.197	18.235	18.273	18.311	18.349	18.387	18.425	18.463	2800
2900	18.501	18.539	18.577	18.615	18.653	18.691	18.729	18.767	18.805	18.843	18.881	18.919	18.957	18.994	19.033	19.070	19.108	19.146	19.183	19.221	2900
3000	19.259	19.297	19.335	19.373	19.410	19.448	19.486	19.524	19.562	19.600	19.638	19.676	19.713	19.751	19.789	19.827	19.864	19.902	19.940	19.977	3000
3100	20.015																				3100

PLATINUM-PLATINUM, 13% RHODIUM THERMOCOUPLES

Degrees Celsius (Centigrade, Int. 1948) Cold End at 25° C (EMF at 0°C = –0.142 mv)

EMF IN ABSOLUTE MILLIVOLTS																					
°C.	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	°C.
0	–0.142	–0.115	–0.087	–0.059	–0.030	0.000	0.030	0.061	0.092	0.123	0.156	0.188	0.221	0.255	0.289	0.323	0.358	0.394	0.430	0.467	0
100	0.503	0.541	0.579	0.617	0.656	0.695	0.735	0.775	0.815	0.856	0.897	0.938	0.979	1.021	1.063	1.105	1.148	1.191	1.235	1.278	100
200	1.323	1.367	1.411	1.456	1.501	1.546	1.592	1.637	1.684	1.730	1.776	1.823	1.870	1.917	1.965	2.012	2.060	2.108	2.156	2.204	200
300	2.253	2.302	2.351	2.400	2.449	2.499	2.548	2.598	2.648	2.698	2.748	2.798	2.849	2.899	2.950	3.001	3.052	3.103	3.154	3.205	300
400	3.257	3.309	3.360	3.412	3.465	3.517	3.570	3.622	3.675	3.728	3.781	3.834	3.887	3.939	3.992	4.045	4.099	4.152	4.206	4.259	400
500	4.313	4.367	4.421	4.476	4.530	4.585	4.640	4.695	4.751	4.806	4.862	4.917	4.973	5.028	5.084	5.140	5.196	5.252	5.308	5.365	500
600	5.421	5.478	5.535	5.592	5.650	5.707	5.765	5.822	5.880	5.937	5.995	6.052	6.110	6.168	6.226	6.285	6.343	6.402	6.460	6.519	600
700	6.578	6.637	6.696	6.756	6.815	6.875	6.934	6.994	7.053	7.113	7.173	7.234	7.294	7.355	7.415	7.476	7.537	7.598	7.659	7.721	700
800	7.782	7.844	7.905	7.967	8.028	8.090	8.152	8.214	8.277	8.339	8.402	8.464	8.527	8.590	8.653	8.716	8.779	8.842	8.905	8.969	800
900	9.033	9.097	9.161	9.225	9.289	9.353	9.417	9.481	9.545	9.610	9.674	9.739	9.804	9.870	9.935	10.001	10.066	10.132	10.197	10.263	900
1000	10.329	10.395	10.461	10.527	10.593	10.659	10.727	10.794	10.861	10.928	10.996	11.063	11.131	11.198	11.266	11.334	11.402	11.471	11.539	11.607	1000
1100	11.675	11.743	11.812	11.880	11.948	12.017	12.085	12.154	12.223	12.292	12.361	12.430	12.499	12.568	12.637	12.706	12.775	12.844	12.913	12.983	1100
1200	13.051	13.121	13.190	13.260	13.329	13.398	13.468	13.537	13.607	13.676	13.746	13.815	13.885	13.954	14.023	14.093	14.162	14.232	14.301	14.371	1200
1300	14.440	14.510	14.579	14.649	14.718	14.787	14.857	14.926	14.996	15.065	15.134	15.203	15.273	15.342	15.411	15.481	15.550	15.619	15.689	15.758	1300
1400	15.827	15.897	15.966	16.036	16.105	16.175	16.244	16.313	16.382	16.452	16.521	16.591	16.660	16.730	16.798	16.868	16.937	17.006	17.075	17.144	1400
1500	17.213	17.282	17.351	17.419	17.489	17.557	17.626	17.695	17.764	17.832	17.901	17.969	18.037	18.106	18.174	18.243	18.311	18.380	18.448	18.517	1500
1600	18.585	18.654	18.722	18.790	18.859	18.927	18.995	19.063	19.131	19.199	19.267	19.335	19.403	19.472	19.540	19.608	19.676	19.744	19.812	19.880	1600
1700	19.948																				1700

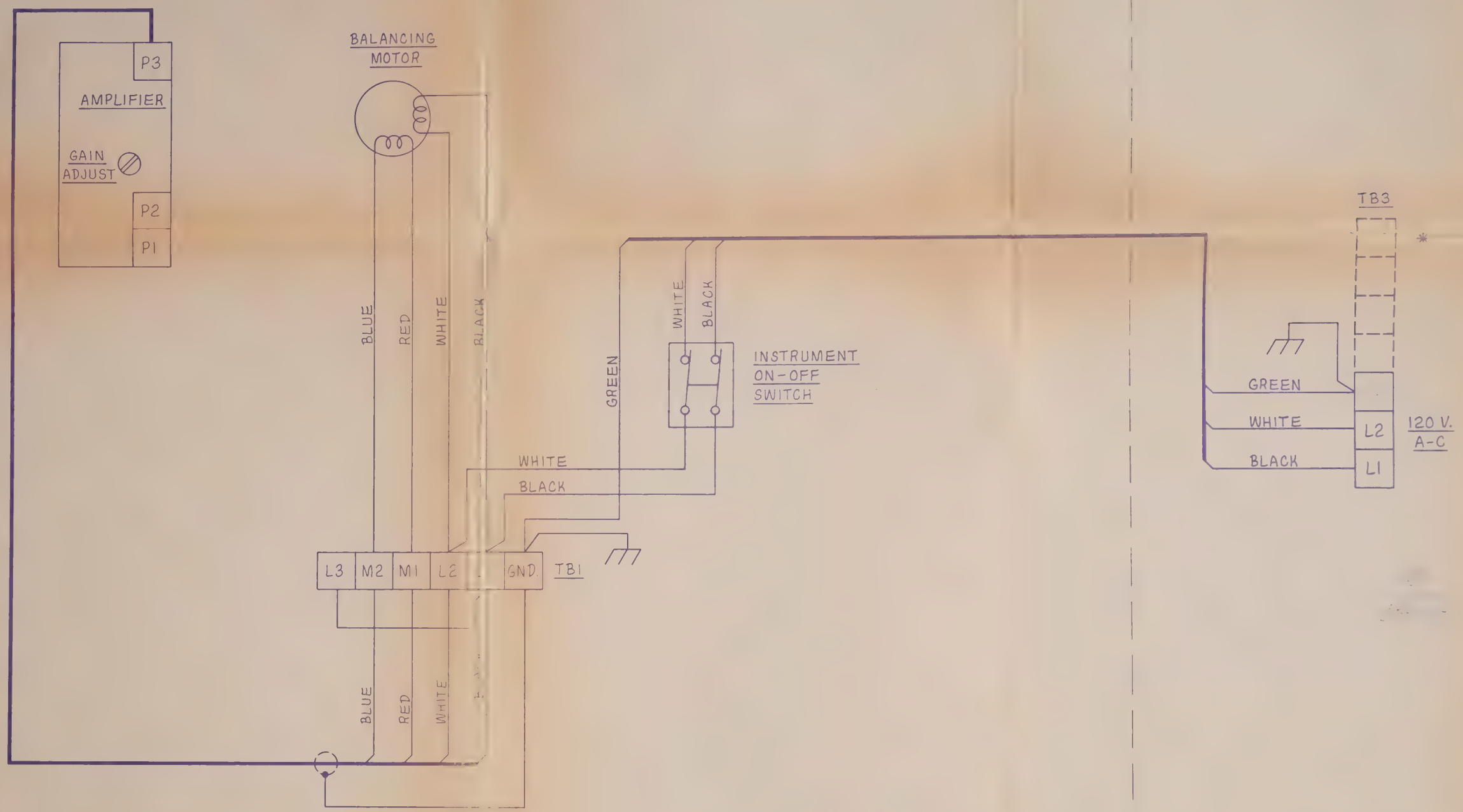
TYPE "Y" (RP1080) IRON-CONSTANTAN THERMOCOUPLE CURVE

Reference Junction at 75°F

Millivolts

°F	-0	-10	-20	-30	-40	-50	-60	-70	-80	-90
-300	-9.13									
-200	-7.27	-7.48	-7.69	-7.89	-8.09	-8.28	-8.46	-8.64	-8.81	-8.98
-100	-4.89	-5.14	-5.39	-5.64	-5.89	-6.13	-6.37	-6.60	-6.83	-7.05
0	-2.18	-2.46	-2.74	-3.02	-3.30	-3.57	-3.84	-4.11	-4.37	-4.63
°F	0	10	20	30	40	50	60	70	80	90
0	-2.18	-1.89	-1.61	-1.32	-1.03	-0.74	-0.44	-0.15	+0.15	+0.44
100	0.74	1.04	1.34	1.64	1.94	2.24	2.55	2.85	3.16	3.46
200	3.77	4.08	4.38	4.69	5.00	5.31	5.62	5.93	6.24	6.55
300	6.86	7.17	7.49	7.80	8.11	8.42	8.74	9.05	9.36	9.67
400	9.98	10.30	10.61	10.92	11.23	11.54	11.85	12.16	12.47	12.78
500	13.09	13.39	13.70	14.01	14.32	14.63	14.94	15.24	15.55	15.86
600	16.17	16.47	16.78	17.08	17.39	17.69	18.00	18.30	18.61	18.92
700	19.22	19.53	19.83	20.14	20.44	20.75	21.05	21.36	21.66	21.97
800	22.27	22.58	22.88	23.19	23.49	23.80	24.11	24.41	24.72	25.03
900	25.33	25.64	25.95	26.26	26.57	26.88	27.19	27.50	27.81	28.13
1000	28.44	28.75	29.07	29.38	29.70	30.02	30.34	30.66	30.98	31.30
1100	31.62	31.94	32.27	32.60	32.92	33.25	33.58	33.91	34.24	34.58
1200	34.91	35.24	35.58	35.92	36.26	36.60	36.94	37.28	37.62	37.97
1300	38.32	38.67	39.02	39.37	39.72	40.08	40.43	40.79	41.14	41.50
1400	41.86	42.22	42.58	42.94	43.30	43.66	44.02	44.39	44.75	45.11
1500	45.48	45.84	46.21	46.57	46.94	47.30	47.67	48.03	48.40	48.76
1600	49.13									

* ADDITIONAL TERMINALS AS REQ'D. PER ATTACHMENT DRAWING.



CONNECTION DIAGRAM, POWER CIRCUIT, SERIES 760-765 DYNAMASTER SINGLE POINT POTENTIOMETER.

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

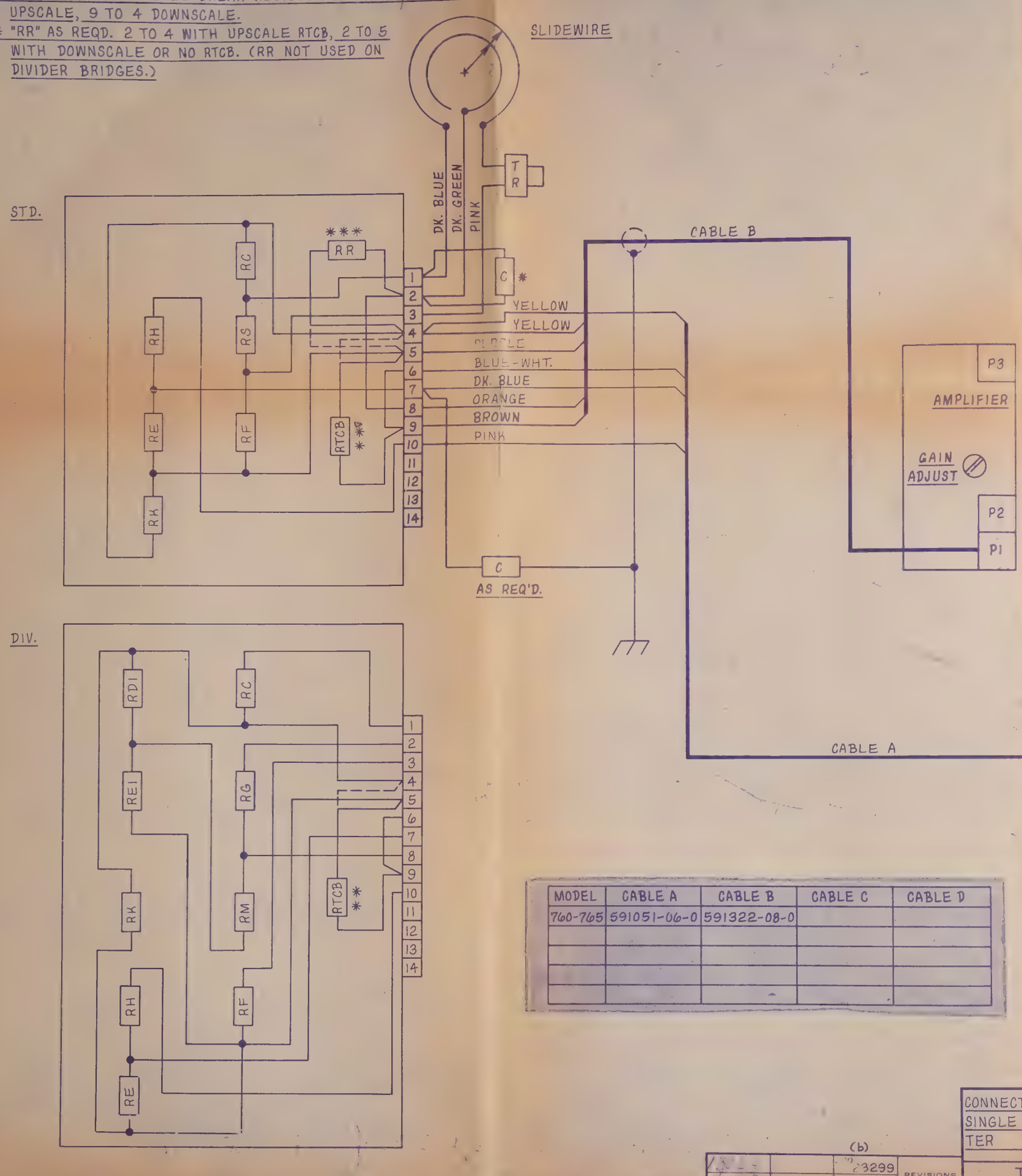
REVISIONS	
-231	
5-77	

DRAWN B.F.H. DATE 5-2[illegible]
TRACED CHECKED APPR
SCALE FILE DR C
NO. 850200-22-9

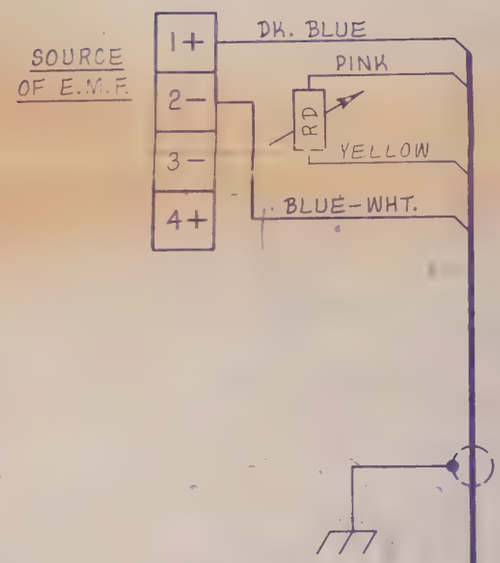
* PT. #308803-00-0 ANTI-BOUNCE CAP. USED ON 1 SEC. D-C ONLY.

** "RTCB" - THERMOCOUPLE BREAK RESISTOR AS REQD. 9 TO 5 UPSCALE, 9 TO 4 DOWNSCALE.

*** "RR" AS REQD. 2 TO 4 WITH UPSCALE RTCB, 2 TO 5 WITH DOWNSCALE OR NO RTCB. (RR NOT USED ON DIVIDER BRIDGES.)



REAR OF CASE



MODEL	CABLE A	CABLE B	CABLE C	CABLE D
760-765	591051-06-0	591322-08-0		

REVISIONS			
		3299	
		10-6-75	

CONNECTION DIAGRAM, MEASURING CIRCUIT, SINGLE POINT SERIES 760-765 DYNAMASTER PYROMETER RECORDER.

THE BRISTOL COMPANY
WATERBURY CONN U.S.A.

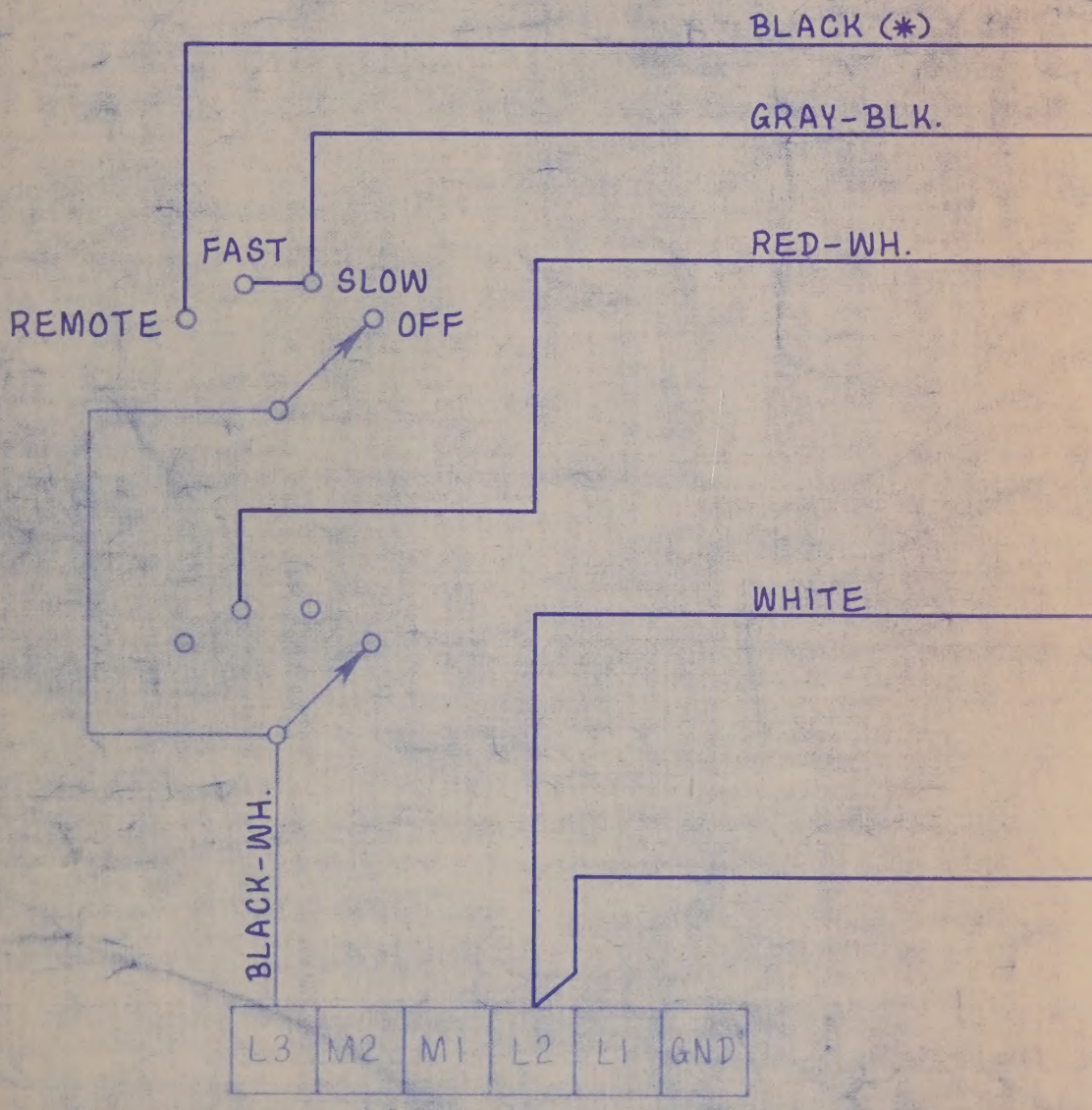
DRAWN BFH	DATE 4-17-74
TRACED	CHECKED
APPROVED	
SCALE	FILE DR C
NO. 850325-41-2	

NOTE:

FOR INSTRUMENTS NOT REQUIRING INTERNAL SWITCH, RE
WIRES TO SWITCH & CONNECT BLACK (*) WIRE TO L3 TER

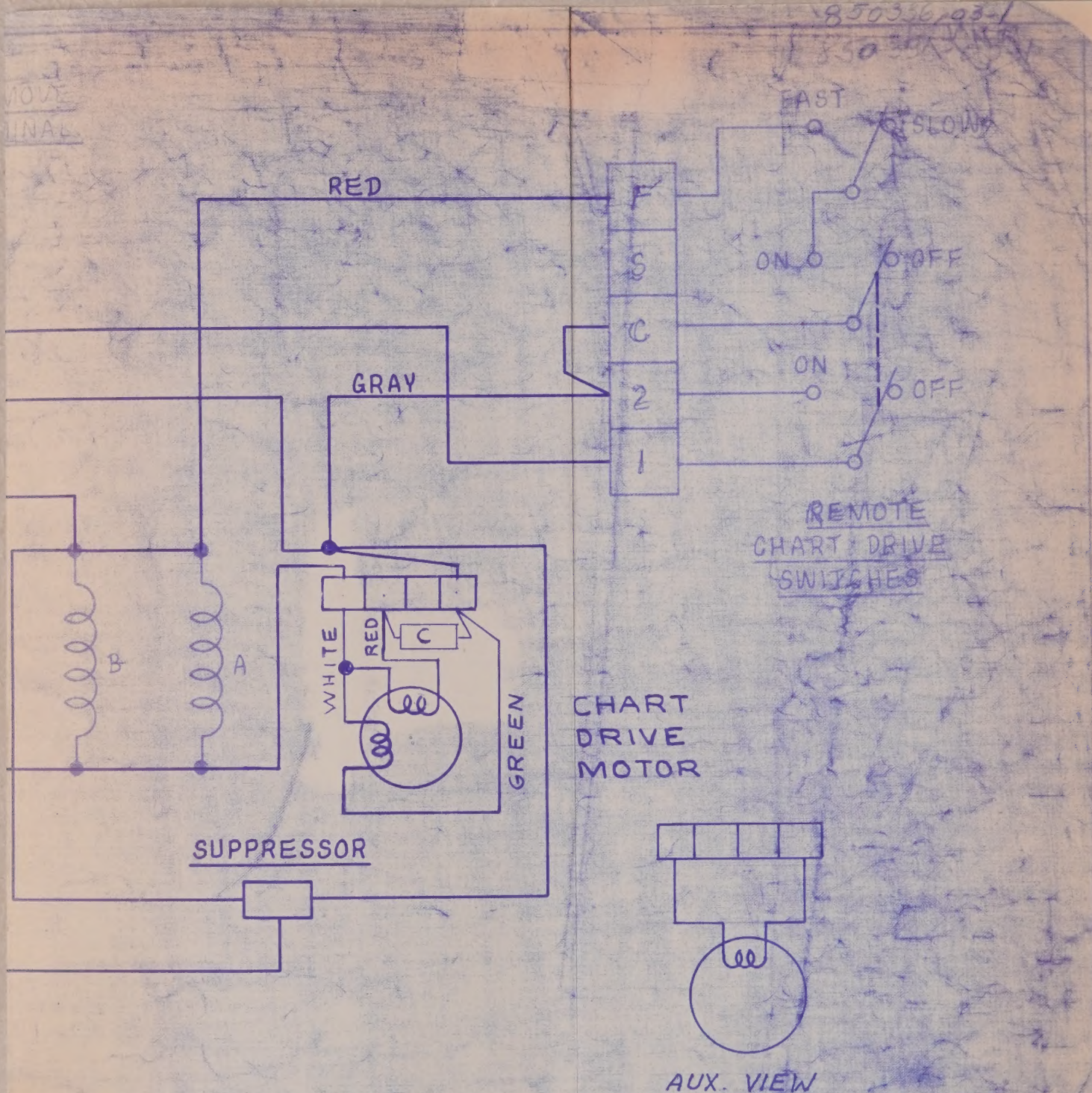
FOR 8:1 RATIO WITH TRANSMISSION B3377

FOR 60:1 RATIO WITH TRANSMISSION B3388



SEE POWER DIAGRAM
FOR ADDITIONAL WIRING

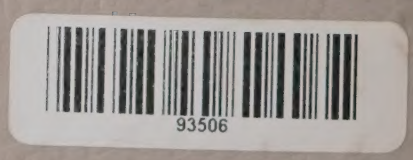
(d) 24643	<1> EC022163	(b) ECO 5387	(b) ECO 5149
3-1-78	4-15-74	9-13-68	8-5-68



CONNECTION DIAGRAM AUXILIARY CIRCUIT, 2 SPEED ELECTRIC CHART DRIVE, SERIES 760 DYNAMASTER RECORDER.

THE BRISTOL COMPANY
WATERBURY, CONN., U.S.A.

DRAWN B.F.H. APPROVED JOY TRACED
CHECKED DATE 4-22-68 SCALE
DRAWER NO. B
SHEET NO. 850336-03-1


93506